FUEL CELL AND ITS OPERATING METHOD

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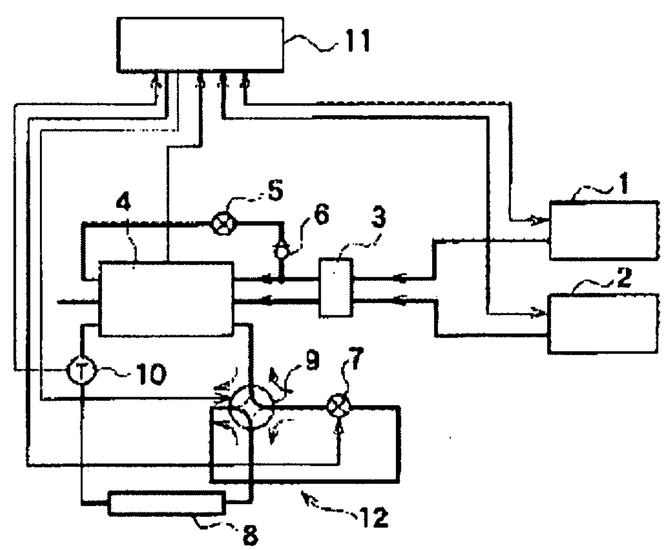
Abstract of **JP2002164065**

PROBLEM TO BE SOLVED: To control the operation of a fuel cell by detecting a wet condition without providing each cell of a fuel-cell stack with a reference electrode.
SOLUTION: A hydrogen-containing gas and air humidified by a humidifier 3 are supplied to the fuel-cell stack 4 from the right side in the figure. A cooling system 12 is comprised of a cooling water pump 7 for circulating cooling water, a radiator for radiating the heat of the cooling water to the outside or a pair 8 of a radiator and radiator fan, a four-way valve 9 for reversing the direction of the cooling water flowing in the stack 4, and a thermometer 10 for measuring the cooling water temperature. The cooling system 12 causes the cooling water to flow into the stack 4 from the left side when the cell voltage is measured for determination of a wet condition, so as to form a relative humidity distribution in the direction of alignment of the cells. A control device 11 determines the wet condition based on the distribution of cell voltages between the cells with low relative humidity and the cells with high relative humidity.



JAPANESE [JP,2002-164065,A]

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] An electrical-potential-difference detection means to detect the electrical potential difference of at least two cels chosen from two or more cels which constitute a fuel cell stack, The humidity distribution means forming which forms relative humidity distribution of fuel gas and oxidation gas in the cel array direction of a fuel cell stack at least at the time of the cel electrical-potential-difference detection by said electrical-potential-difference detection means, The fuel cell with which relative humidity is characterized by having investigated the distribution of voltage for every cel which said electrical-potential-difference detection means detected, and having a damp or wet condition judging means to judge with the humidity of a fuel cell being inadequate when low, compared with the electrical potential difference of a cel with the high electrical potential difference of a cel with low relative humidity.
[Claim 2] Said humidity distribution means forming is the fuel cell according to claim 1 characterized by to be changing to hard flow at the time of the electrical-potential-difference detection by said electrical-potential-difference detection means for the damp-or-wet-condition judging by said damp-or-wet-condition judging means, and to be a cooling means form relative-humidity distribution of fuel gas and oxidation gas in the cel array direction of a fuel cell stack while usually making the inflow direction and the cooling-water inflow direction of fuel gas and oxidation gas of a fuel cell stack into this direction at the time of operation.
[Claim 3] Said humidity distribution means forming is a fuel cell according to claim 1 which always makes hard flow the inflow direction and the cooling water inflow direction of a fuel cell stack of fuel gas and oxidation gas, and is characterized by being a cooling means to form relative humidity distribution of fuel gas and oxidation gas in the cel array direction of a fuel cell stack.
[Claim 4] An electrical-potential-difference amperometry means to measure the electrical potential difference and current under fuel cell stack operation, An internal resistance presumption means to presume the internal resistance value of a fuel cell stack based on the volt ampere characteristic which this electrical-potential-difference amperometry means measured, The fuel cell characterized by having a damp or wet condition judging means to judge the damp or wet condition of a fuel cell based on the comparison with the certified value beforehand remembered to be said presumed internal resistance value, and a load limitation

means to restrict the output of a fuel cell when it judges with this damp or wet condition judging means of humidity being inadequate.
[Claim 5] The fuel cell according to claim 4 characterized by having further a thermometry means to measure the temperature of a fuel cell, and a certified value modification means to change said certified value based on the measured temperature.
[Claim 6] The fuel cell characterized by to have an influent daily dose detection means detect the moisture content of the fuel gas which flows into a fuel cell stack, and oxidation gas, an effluent daily dose detection means detect the moisture content of the fuel gas which flows out of a fuel cell stack, and oxidation gas, a generation moisture content presumption means presume the moisture content generated inside the fuel cell stack, and a damp-or-wet-condition judging means judge the damp or wet condition of a fuel cell based on said moisture content, influent daily dose, and effluent daily dose which were generated.
[Claim 7] The fuel cell of claim 1 characterized by having further a load limitation means to restrict the output of a fuel cell when it judges with said damp or wet condition judging means of humidity being inadequate thru/or claim 6 given in any 1 term.
[Claim 8] Like the humidity distribution formation fault which forms relative humidity distribution of fuel gas and oxidation gas in the cel array direction of a fuel cell stack The electrical-potential-difference detection process in which the electrical potential difference of at least two cels chosen from two or more cels which constitute a fuel cell stack is detected, When the distribution of voltage for every cel was investigated, and low [compared with the electrical potential difference of a cel with high relative humidity] and the electrical potential difference of a cel with low relative humidity judges with humidity being inadequate in the damp or wet condition judging process judged as the humidity of a fuel cell being inadequate, and said damp or wet condition judging process, The operating method of the fuel cell characterized by having the load limitation process in which the output of a fuel cell is restricted.
[Claim 9] The electrical-potential-difference amperometry process which measures the electrical potential difference and current under fuel cell stack operation, The internal resistance presumption process in which the internal resistance value of a fuel cell stack is presumed based on said measured volt ampere characteristic, When it judges with humidity being inadequate based on the comparison with the certified value beforehand remembered to be said presumed internal resistance value in the damp or wet condition judging process in which the damp or wet condition of a fuel cell is judged, and said damp or wet condition judging process, The operating method of the fuel cell characterized by having the load limitation process in which the output of a fuel cell is restricted.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the fuel cell which can be built over the fuel cell of a solid oxide type, and its operating method, especially can control the humidity of an electrode or an electrolyte membrane appropriately, and its operating method.
[0002]
[Description of the Prior Art] The fuel cell technique attracts attention to the environmental problem in recent years, especially the problem of the global warming by the air pollution by exhaust gas and the carbon dioxide of an automobile as the power source which makes possible clean exhaust air and high energy efficiency, or a source of power.
[0003] The single cel of a fuel cell joins the electrode which includes a catalyst in the both sides of the electrolyte membrane which is an ion conductor, and is constituted. And fuel gas, oxidation gas, for example, the gas containing hydrogen, and air are supplied to two electrodes, respectively. In the anode (fuel electrode) to which hydrogen is supplied, hydrogen ionizes into a hydrogen ion and an electron. In an electron, return and a hydrogen ion arrive at an anode plate through an electrolyte membrane at a cathode (air pole) through an external circuit. In the cathode to which the oxygen in air is supplied, a hydrogen ion, oxygen, and an electron react and water is generated.
[0004] The stack structure which it usually accumulated two or more cels with about 1.2 V since the theoretical electromotive force of the single cel of a fuel cell was low, and was made into series connection is used. The solid-state polyelectrolyte mold fuel cell which has high power density especially also in a fuel cell attracts attention as sources for mobiles of power, such as an automobile.
[0005] In operation of such a fuel cell, an important point is keeping proper the damp or wet condition of an electrode catalyst and the solid-state polyelectrolyte film. If these tend to dry, ionic conductivity will fall and the internal resistance as a power plant will increase. If humidity passes with the generation water by the reaction of hydrogen and oxygen etc., the effective electrode surface product which incorporates gas will decrease, and the output current will decrease.
[0006] It considers as the technique which controls the damp or wet condition of the electrode in the conventional fuel cell, and the solid-state polyelectrolyte film

proper, and the technique given in JP,7-22047,A is known. According to this conventional technique, the reference electrode in which the reference potential stabilized in the fuel cell is shown was prepared, the anode of a cel to this reference electrode and the potential of a cathode were measured, and the amount of humidification of fuel gas or oxidation gas was adjusted based on this potential.
[0007]
[Problem(s) to be Solved by the Invention] However, since the above-mentioned conventional technique had become the configuration of measuring the potential of the anode to the reference electrode in a fuel cell, and a cathode, there was a trouble that application was impossible in the fuel cell which does not have the reference electrode.
[0008] Moreover, since the above-mentioned conventional technique had become the configuration of judging the excess of moisture, or desiccation of the film, by change of the anode to the output current, and cathode potential, when the above output current was not pulled out to some extent, a unique reaction was not seen but it had the trouble that the judgment of a damp or wet condition was difficult.
[0009] Furthermore, since both the excess of moisture and desiccation of the film may become a cause when the singularity of potential change is accepted in an anode and cathode two poles, the above-mentioned conventional technique requires time amount for both distinction. It was specifically once made dryness, and after measuring the potential change, since both distinction was judged, the trouble that immediate output recovery was difficult was for the first time.
[0010] It is offering the fuel cell which detects a damp or wet condition and can control operation, and its operating method, without the purpose of this invention preparing a reference electrode in each cel of a fuel cell in view of the above trouble.
[0011] Moreover, especially the purpose of this invention is offering the fuel cell which can judge a damp or wet condition easily, and its operating method, without pulling out the output current of a fuel cell.
[0012] Furthermore, the purpose of this invention is offering the fuel cell which can judge easily whether it having changed in hydration or which direction of desiccation from the proper damp or wet condition, and its operating method.
[0013]
[Means for Solving the Problem] An electrical-potential-difference detection means to detect the electrical potential difference of at least two cels chosen from two or more cels which constitute a fuel cell stack in order that invention according to claim 1 might solve the above-mentioned technical problem, The humidity distribution means forming which forms relative humidity distribution of fuel gas and oxidation gas in the cel array direction of a fuel cell stack at least at the time of the cel electrical-potential-difference detection by the electrical-potential-difference detection means, Relative humidity is the fuel cell which makes it a summary to have investigated the distribution of voltage for every cel which the electrical-potential-difference detection means detected, and to have had a damp or wet condition judging means to judge with the humidity of a fuel cell being inadequate when low compared with the electrical potential difference of a cel with the high electrical potential difference of a cel with low relative humidity.

[0014] Invention according to claim 2 is set to a fuel cell according to claim 1 in order to solve the above-mentioned technical problem. Said humidity distribution means forming While usually making the inflow direction and the cooling water inflow direction of a fuel cell stack of fuel gas and oxidation gas into this direction at the time of operation Let it be a summary to be a cooling means to form relative humidity distribution of fuel gas and oxidation gas in the cel array direction of a fuel cell stack by changing to hard flow at the time of the electrical-potential-difference detection by said electrical-potential-difference detection means for the damp or wet condition judging by said damp or wet condition judging means.
[0015] In order that invention according to claim 3 may solve the above-mentioned technical problem, in a fuel cell according to claim 1, said humidity distribution means forming always makes hard flow the inflow direction and the cooling water inflow direction of a fuel cell stack of fuel gas and oxidation gas, and makes it a summary to be a cooling means to form relative humidity distribution of fuel gas and oxidation gas in the cel array direction of a fuel cell stack.
[0016] An electrical-potential-difference amperometry means to measure the electrical potential difference and current under fuel cell stack operation in order that invention according to claim 4 may solve the above-mentioned technical problem, An internal resistance presumption means to presume the internal resistance value of a fuel cell stack based on the volt ampere characteristic which this electrical-potential-difference amperometry means measured, It is the fuel cell which makes it a summary to have had a damp or wet condition judging means to judge the damp or wet condition of a fuel cell, based on the comparison with the certified value beforehand remembered to be this presumed internal resistance value.
[0017] Invention according to claim 5 makes it a summary to have had further a thermometry means to measure the temperature of a fuel cell, and a certified value modification means to change said certified value based on the measured temperature in a fuel cell according to claim 4 in order to solve the above-mentioned technical problem.
[0018] An influent daily dose detection means to detect the moisture content of the fuel gas which flows into a fuel cell stack, and oxidation gas in order that invention according to claim 6 may solve the above-mentioned technical problem, An effluent daily dose detection means to detect the moisture content of the fuel gas which flows out of a fuel cell stack, and oxidation gas, It is the fuel cell which makes it a summary to have had a generation moisture content presumption means to presume the moisture content generated inside the fuel cell stack, and a damp or wet condition judging means to judge the damp or wet condition of a fuel cell based on said moisture content, influent daily dose, and effluent daily dose which were generated.
[0019] When it judges with said damp or wet condition judging means of humidity being inadequate in the fuel cell of claim 1 thru/or claim 6 given in any 1 term, invention according to claim 7 makes it a summary to have had further a load limitation means to restrict the output of a fuel cell, in order to solve the above-mentioned technical problem.
[0020] Invention according to claim 8 like the humidity distribution formation fault

which forms relative humidity distribution of fuel gas and oxidation gas in the cel array direction of a fuel cell stack in order to solve the above-mentioned technical problem The electrical-potential-difference detection process in which the electrical potential difference of at least two cels chosen from two or more cels which constitute a fuel cell stack is detected, When the distribution of voltage for every cel was investigated, and low [compared with the electrical potential difference of a cel with high relative humidity] and the electrical potential difference of a cel with low relative humidity judges with humidity being inadequate in the damp or wet condition judging process judged as the humidity of a fuel cell being inadequate, and this damp or wet condition judging process, It is the operating method of the fuel cell which makes it a summary to have had the load limitation process in which the output of a fuel cell was restricted.

[0021] The electrical-potential-difference amperometry process which measures the electrical potential difference and current under fuel cell stack operation in order that invention according to claim 9 may solve the above-mentioned technical problem, The internal resistance presumption process in which the internal resistance value of a fuel cell stack is presumed based on this measured volt ampere characteristic, When it judges with humidity being inadequate based on the comparison with the certified value beforehand remembered to be this presumed internal resistance value in the damp or wet condition judging process in which the damp or wet condition of a fuel cell is judged, and this damp or wet condition judging process, It is the operating method of the fuel cell which makes it a summary to have had the load limitation process in which the output of a fuel cell was restricted.

[0022]

[Effect of the Invention] An electrical-potential-difference detection means to detect the electrical potential difference of at least two cels which were chosen from two or more cels which constitute a fuel cell stack according to invention according to claim 1, The humidity distribution means forming which forms relative humidity distribution of fuel gas and oxidation gas in the cel array direction of a fuel cell stack at least at the time of the cel electrical-potential-difference detection by said electrical-potential-difference detection means, Since the distribution of voltage for every cel which said electrical-potential-difference detection means detected was investigated, and the electrical potential difference of a cel with low relative humidity was equipped with a damp or wet condition judging means to judge with the humidity of a fuel cell being inadequate when low compared with the electrical potential difference of a cel with high relative humidity The effectiveness that it can judge correctly whether hydration or the moisture of the damp or wet condition of a fuel cell is insufficient based on the measurement result of the electrical potential difference of a cel with high relative humidity and the electrical potential difference of a cel with low relative humidity is done so. Moreover, since the judgment of a damp or wet condition becomes exact, an unnecessary hydrogen purge is reduced and the effectiveness of improving the fuel consumption of a fuel cell is done so.

[0023] According to invention according to claim 2, to an effect of the invention according to claim 1 in addition, said humidity distribution means forming While

usually making the inflow direction and the cooling water inflow direction of a fuel cell stack of fuel gas and oxidation gas into this direction at the time of operation By changing to hard flow at the time of the electrical-potential-difference detection by said electrical-potential-difference detection means for the damp or wet condition judging by said damp or wet condition judging means Since it is a cooling means to form relative humidity distribution of fuel gas and oxidation gas in the cel array direction of a fuel cell stack Usually, the effectiveness that an exact damp or wet condition can be judged is done so, without forming relative humidity distribution of the both sides of relative humidity distribution suitable at the time of operation and relative humidity distribution suitable at the time of a damp or wet condition judging, and usually reducing the generating efficiency at the time of operation.

[0024] According to invention according to claim 3, to an effect of the invention according to claim 1 in addition, said humidity distribution means forming Since the inflow direction and the cooling water inflow direction of a fuel cell stack of fuel gas and oxidation gas were always made into hard flow and it is a cooling means to form relative humidity distribution of fuel gas and oxidation gas in the cel array direction of a fuel cell stack The effectiveness that an exact damp or wet condition can be judged is done so, without preparing the cooling water inflow direction change function, and complicating a cooling means.

[0025] An electrical-potential-difference amperometry means to measure the electrical potential difference and current under fuel cell stack operation according to invention according to claim 4, An internal resistance presumption means to presume the internal resistance value of a fuel cell stack based on the volt ampere characteristic which this electrical-potential-difference amperometry means measured, The effectiveness that a damp or wet condition can be judged is done so, without forming relative humidity distribution in a fuel cell stack, since it had a damp or wet condition judging means to judge the damp or wet condition of a fuel cell, based on the comparison with the certified value beforehand remembered to be said presumed internal resistance value.

[0026] Since it had [according to invention according to claim 5] further a thermometry means to measure the temperature of a fuel cell, and a certified value modification means to change said certified value based on the measured temperature in addition to the effect of the invention according to claim 4, even if the operating temperature of a fuel cell has change, the effectiveness that an exact damp or wet condition judging can be performed is done so.

[0027] An influent daily dose detection means to detect the moisture content of the fuel gas which flows into a fuel cell stack, and oxidation gas according to invention according to claim 6, An effluent daily dose detection means to detect the moisture content of the fuel gas which flows out of a fuel cell stack, and oxidation gas, By having had a generation moisture content presumption means to presume the moisture content generated inside the fuel cell stack, and a damp or wet condition judging means to judge the damp or wet condition of a fuel cell based on said moisture content, influent daily dose, and effluent daily dose which were generated The change hysteresis of the moisture content inside a fuel cell stack is pursued correctly, and the effectiveness that the damp or wet condition of a fuel

cell can be judged correctly is done so.
[0028] Since it had further a load limitation means to restrict the output of a fuel cell when it judged [according to invention according to claim 7] with said damp or wet condition judging means of humidity being inadequate in addition to claim 1 thru/or an effect of the invention according to claim 6, the effectiveness that recovery from dryness and continuation of operation of a fuel cell can be reconciled is done so.
[0029] According to invention according to claim 8, like the humidity distribution formation fault which forms relative humidity distribution of fuel gas and oxidation gas in the cel array direction of a fuel cell stack The electrical-potential-difference detection process in which the electrical potential difference of at least two cels chosen from two or more cels which constitute a fuel cell stack is detected, When the distribution of voltage for every cel was investigated, and low [compared with the electrical potential difference of a cel with high relative humidity] and the electrical potential difference of a cel with low relative humidity judges with humidity being inadequate in the damp or wet condition judging process judged as the humidity of a fuel cell being inadequate, and said damp or wet condition judging process, Since it had the load limitation process in which the output of a fuel cell was restricted, the effectiveness that it can judge correctly whether hydration or the moisture of the damp or wet condition of a fuel cell is insufficient based on the measurement result of the electrical potential difference of a cel with high relative humidity and the electrical potential difference of a cel with low relative humidity is done so. Moreover, since the judgment of a damp or wet condition becomes exact, an unnecessary hydrogen purge is reduced and the effectiveness of improving the fuel consumption of a fuel cell is done so.
[0030] The electrical-potential-difference amperometry process which measures the electrical potential difference and current under fuel cell stack operation according to invention according to claim 9, The internal resistance presumption process in which the internal resistance value of a fuel cell stack is presumed based on said measured volt ampere characteristic, When it judges with humidity being inadequate based on the comparison with the certified value beforehand remembered to be said presumed internal resistance value in the damp or wet condition judging process in which the damp or wet condition of a fuel cell is judged, and said damp or wet condition judging process, The effectiveness that a damp or wet condition can be judged is done so, without forming relative humidity distribution in a fuel cell stack, since it had the load limitation process in which the output of a fuel cell was restricted. Moreover, since the judgment of a damp or wet condition becomes exact, an unnecessary hydrogen purge is reduced and the effectiveness of improving the fuel consumption of a fuel cell is done so.
[0031]
[Embodiment of the Invention] Next, the gestalt of operation of this invention is explained to a detail with reference to a drawing.
[1st operation gestalt] Drawing 1 is a whole block diagram explaining the configuration of the 1st operation gestalt of the fuel cell concerning this invention. The hydrogen feed zone 1 which supplies the gas (following and hydrogen content gas) by which a fuel cell contains the hydrogen as fuel gas by desired pressure and

flow rate in drawing 1 , The air supply section 2 which supplies the air as oxidation gas by desired pressure and flow rate, The humidifier 3 which humidifies hydrogen content gas and air with the pure water supplied from the pure-water feeder which is not illustrated, respectively, The fuel cell stack 4 to which the hydrogen content gas and air which were humidified with the humidifier 3 are supplied, While cooling the pump 5 for fuel circulation to which recycling of the hydrogen which was not used is carried out, the check valve 6 which prevents the back flow of hydrogen content gas, and the fuel cell stack 4 At the time of the amplitude measurement for a damp or wet condition judging, it has the cooling system 12 which can make hard flow the inflow direction of the cooling water to the fuel cell stack 4 with the gas inflow direction to the fuel cell stack 4, and the control unit 11 which controls these equipments.
[0032] The electrical-potential-difference detector which are two or more cels chosen from two or more cels which constitute a stack, and an electrical-potential-difference detection means to detect each electrical potential difference of all cels preferably and which is not illustrated is formed in the fuel cell stack 4, and the detecting signal of this electrical-potential-difference detector is told to it to a control unit 11.
[0033] A cooling system 12 is equipped with the cooling-water passage which was established in the interior of the fuel cell stack 4 and which is not illustrated, the cooling water pump 7 made to circulate through cooling water, the radiator or the radiator which radiates heat to the exterior in the heat of cooling water, and a radiator fan's group 8, the method valve 9 of four which reverses the direction of the cooling water which flows to the fuel cell stack 4, the thermometer 10 which measure a circulating water temperature, the duct which connect these, and the cooling water with which these interior was filled up.
[0034] And the cooling system 12 constitutes the humidity distribution means forming which forms relative humidity distribution of fuel gas and oxidation gas in the cel array direction of a fuel cell stack at the time of the cel electrical-potential-difference detection by the electrical-potential-difference detection means.
[0035] Moreover, while a control unit 11 receives the hydrogen feed zone 1, the air supply section 2, and the detecting signal from a thermometer 10, it sends out the control signal which controls the hydrogen feed zone 1, the air supply section 2, a cooling water pump 7, and the method valve 9 of four.
[0036] Next, an operation of the relative humidity distribution formation by the cooling system 12 is explained. After the hydrogen content gas and air which are supplied from the hydrogen feed zone 1 and the air supply section 2 pass a humidifier 3 and serve as suitable humidity, they are supplied from the drawing Nakamigi side of the fuel cell stack 4. It is thought that absolute humidity does not fall and absolute humidity goes up them rather since this hydrogen content gas and air are further humidified by the moisture which generates the interior of the fuel cell stack 4 by generation of electrical energy as it flows from the right to the left after they are humidified by a certain absolute humidity with a humidifier 3.
[0037] According to the control from a control unit 11, the method valve 9 of four which changes the direction of cooling water is usually changed so that cooling

water may be poured in the direction of an arrow head of a broken line at the time of electrical-potential-difference detection according cooling water to a sink and an electrical-potential-difference detector to the direction of an arrow head of a continuous line in the time of operation. Since the cooling water which flows the fuel cell stack 4 by this usually flows from drawing Nakamigi to the left at the time of operation, the temperature distribution in the fuel cell stack 4 at this time have a low drawing Nakamigi side, and left-hand side becomes high.
[0038] On the other hand, since cooling water flows from ****** to the right contrary to the direction where gas flows at the time of the amplitude measurement for a damp or wet condition judging, the temperature distribution in the fuel cell stack 4 at this time usually have a high drawing Nakamigi side contrary to the time of operation, and left-hand side becomes low. Therefore, relative humidity distribution of the fuel cell stack 4 at the time of an amplitude measurement has a low drawing Nakamigi side, and left-hand side becomes high.
[0039] Where such relative humidity distribution is formed, when each temperature of two or more cels of the fuel cell stack 4 is measured, according to the location of the measured cel, the electrical potential difference of a cel with low relative humidity and the electrical potential difference of a cel with high relative humidity will be measured.
[0040] In addition, relative humidity distribution may always be made to be formed in a fuel cell stack by making the gas inflow direction and cooling water close flow direction to a fuel cell stack into an opposite direction as a modification of the 1st operation gestalt, without usually changing the direction of cooling water in the time of operation and the amplitude measurement for a damp or wet condition judging. According to this modification, although it becomes the configuration which omits the method valve of four which changes the direction of cooling water, and is shown in drawing 2 , it is unavoidable that some falls usually arise in the generating efficiency at the time of operation.
[0041] Next, actuation of the 1st operation gestalt is explained with reference to the flow chart of drawing 3 . The current under fuel cell stack operation and detection of an electrical potential difference are first performed at step (a step is hereafter abbreviated to S) 101. Subsequently, in S102, it returns to S101 again, without carrying out the processing flow of this operation gestalt shown in less than [S103], if it judges whether sag is carried out and sag is not accepted from the current potential property of having memorized beforehand the combination of this detected current/electrical potential difference.
[0042] When sag is accepted, it supposes that it is necessary to judge the cause of sag with a sufficient precision that an electrical potential difference should be recovered appropriately, and with this operation gestalt, the method valve 9 of four is changed so that the circulation direction of cooling water may turn into the I/O direction to the fuel cell stack 4 of gas, such as hydrogen and air, to hard flow by S103. Of the change of this cooling water inflow direction, distribution of relative humidity is formed in the cel array direction as mentioned above in the fuel cell stack 4.
[0043] In addition, like the modification of the 1st operation gestalt shown in drawing 2 , the inflow direction of the cooling water to a fuel cell stack is always

set as hard flow with the inflow direction of gas, and when it has composition which does not change the cooling water inflow direction, these S103 is omitted.
[0044] Moreover, when the existence of sag is judged and sag is judged, although [S102] below this step is performed, it is good also as a configuration which deletes S101 and S102 and performs processing not more than S103 periodically.
[0045] Subsequently, where distribution of relative humidity is formed in the cel array direction, an electrical-potential-difference detector detects the electrical potential difference of each cel which constitutes a fuel cell stack from S104, and a detection value is told to a control unit 11. Although the fuel cell stack 4 consists of two or more cels, it is more desirable to consider the cel electrical potential difference of these plurality as the configuration which can detect the value of the same time of day as much as possible.
[0046] Subsequently, in S105, the inclination of the cel electrical potential difference by the location of each cel is judged, and it judges whether it is what the cause of sag depends on desiccation of the film by S106.
[0047] Although drawing 4 is an example of the cel distribution of voltage corresponding to each cel location, it is drawing which arranged the electrical potential difference of each cel in order, and expressed it toward the outlet side from the gas inlet side. When the inclination for it to apply to an outlet side from a gas inlet side, and for a cel electrical potential difference to become high like this drawing 4 is acquired, it will judge, if the film does not fully carry out humidity but is in dryness.
[0048] It is possible to judge that this means that the electrical potential difference of the cel of a part with low relative humidity is lower than the electrical potential difference of a cel with high relative humidity, namely, the film of the cel of a part with low relative humidity does not fully carry out humidity, but it causes [of the electrical potential difference] a fall.
[0049] Moreover, although it is the case where correlation is not looked at by distribution of relative humidity, and especially distribution of a cel electrical potential difference when cel distribution of voltage as shown in drawing 5 is acquired namely, it is judged that humidity of the film is fully carried out in this case. In the condition that there is no correlation in a cel electrical potential difference and relative humidity, though a cel electrical potential difference is lower than expected value, the film is not dry and you may judge it as what is depended on other causes, for example, the fall of a hydrogen partial pressure etc.
[0050] In addition, when distribution as shown in drawing 6 in this operation gestalt is acquired, it is the case where distribution which is low to the cel electrical potential difference of a part with the low relative humidity by the side of a gas outlet is acquired, but moisture accumulates in the cel of a part with high relative humidity in this case, and if the electrical potential difference is falling by reduction of reaction area, it can judge.
[0051] As mentioned above, when the cause of sag is judged to be what is depended on desiccation of the film, a fuel cell stack output is restricted and the upper limit in which an output request is possible is notified to the control means (not shown) of the high order which controls (S107-109), simultaneously orders it the output request of a fuel cell stack to the fuel cell control means 11 so that it

may not become below the set point with a stack electrical potential difference.
[0052] Thereby, since the operation of a demand command value is attained recognizing the maximum of the power which a fuel cell stack can take out, the control means of a high order can prevent the condition of saying that it is not outputted unexpectedly.
[0053] In addition, the result of having presumed the membranous damp or wet condition like S104-S106 according to the inclination according to the location of each cel electrical potential difference may perform load limitation of a fuel cell stack.
[0054] Moreover, although it is the electrical potential difference of a fuel cell stack, and the control means of an output, it may connect with a fuel cell stack, a DC to DC converter with a current control function may be carried out, and, for details, it omits.
[0055] Moreover, when the cause of sag is except desiccation of the film, the block which performs processing corresponding to the cause is performed. For example, when nitrogen concentration goes up to a hydrogen pole side and the hydrogen partial pressure is falling as a result, it controls to raise a hydrogen partial pressure by purging a hydrogen pole (S110).
[0056] As an example, when hydrogen is the circulatory system, although a hydrogen pole purge is possible, since it is not the essence of this invention, it omits for details by discharging to the system exterior, without returning the exhausted hydrogen from a fuel cell stack, and increasing a hydrogen flow rate to coincidence.
[0057] [2nd operation gestalt] The configuration of this operation gestalt is the same as that of drawing 1 which shows the 1st operation gestalt. In addition, in this operation gestalt, since it is not necessary to necessarily make reverse the inflow direction of gas, and the inflow direction of cooling water, the method valve 9 of four is omissible.
[0058] The flow chart of this operation gestalt is shown in drawing 7 . This operation gestalt measures the current and electrical potential difference under operation of a fuel cell stack beyond a certain fixed time amount or more than the certain fixed number of samplings, calculates an internal resistance value from the measured current and an electrical potential difference, and presumes membranous dryness from the value.
[0059] It is equivalent to the inclination of the interstitial segment in the current-voltage characteristic indicated to be an internal resistance value here to drawing 10 (a). Ionic conductivity falls and it is observed in a form like increase of electric resistance as a membranous moisture content decreases.
[0060] namely, -- if humidity is carried out enough, will become the property (it considers as a standard property hereafter) which shows the highest electrical potential difference in drawing 10 (a), but the electrical potential difference when pulling out the same current value from a fuel cell stack falls, and the inclination of an abbreviation bay is sudden as it becomes with some desiccation -- becoming -- a result -- a form [like the lower left] whose current-voltage characteristic is -- changing -- ******** .
[0061] Moreover, although the inclination of this abbreviation bay is the same as it

of a standard property, when beyond a certain current value is taken out and the fall of an electrical potential difference is accepted rapidly (drawing 10 (b)), the membranous damp or wet condition is suitable, but to the current which the condition (a flow rate and pressure) of gas took out, if not suitable, it will judge.
[0062] Moreover, it can be judged that it becomes the volt ampere characteristic when the condition of drawing 10 (a) and drawing 10 (b) occurs in coincidence, as shown in drawing 10 (c), and membranous humidity is liable to insufficient, and the condition of gas is not suitable when the inclination of an abbreviation bay is more sudden than a standard property, and beyond a certain current value is taken out, a property separates from a straight line and an electrical potential difference falls.

[0063] The flow chart of drawing 7 which asks below for internal resistance based on the volt ampere characteristic measured during operation of a fuel cell stack is explained.
[0064] The current and electrical potential difference of a fuel cell stack of **** time of day are first detected by S201. This time of day of this timing is as much as possible more desirable. Subsequently, in S202, data are filtered with the value of the detected current. Since the effect of internal resistance has not come out of the property in the minimum current region, this is for cutting the data of such a field. In S203, in order to refer to by the internal resistance operation mentioned later, the measured current and the group data of an electrical potential difference are recorded on a record means.
[0065] In S204, the recorded current and the group data of an electrical potential difference judge whether it is sufficient thing for internal resistance calculation. It may be recorded beyond the set point that has that current values are scattered enough broadly and the number of group data as conditions judge that are enough. In S205, internal resistance is actually calculated. Two or more currents and the group data of an electrical potential difference are approximated in a straight line, and, specifically, it asks for them from the slope of a line.
[0066] In addition, about the approach of approximating the group data of two or more current/electrical potential differences in a straight line, there are the least square method which asks for the approximation straight line from which the sum total of the square of the distance from the point which shows class data to an approximation straight line serves as min, an approach shown in JP,6-174808,A.
[0067] The inclination of the abbreviation bay for which it asked by the above approaches is compared with the standard property beforehand searched for in the experiment etc., when an inclination is sudden, it judges that the film is dry, and it processes restricting an output etc., and it becomes possible to stop bad influences, such as degradation of a stack. moreover, the inclination of an abbreviation bay -- it of a standard property, and abbreviation -- it is the same, and the nitrogen accumulated in the hydrogen pole by performing purge processing is discharged, a hydrogen partial pressure is recovered [it supposes that a problem is in gas conditions when the fall of an electrical potential difference is accepted in beyond a certain current value, and], and it becomes possible to return to the standard property of an electrical potential difference.
[0068] In addition, since the internal resistance of a fuel cell has the temperature

characteristics, such as resistance of an electrode, and electrolytic ion conductivity, it is desirable to change the certified value of internal resistance according to the measurement result of the thermometer 10 which measures cooling water temperature, for example. The map for which it specifically asked experimentally, and an amendment formula are used.
[0069] [3rd operation gestalt] Drawing 8 is the whole block diagram showing the configuration of the 3rd operation gestalt of the fuel cell concerning this invention. This operation gestalt is the example which deleted the method valve 9 of four, made the cooling water inflow direction to the fuel cell stack 4 always the same as that of the gas inflow direction to the 1st operation gestalt shown in drawing 1 , and formed the moisture flow rate detection means in hydrogen content gas and the fuel cell stack I/O section of air.
[0070] That is, a moisture flow rate detection means 21 detect the moisture flow rate which flows into the fuel cell stack 4 from the hydrogen feed zone 1, a moisture flow rate detection means 22 detect the moisture flow rate which flows out of a hydrogen outlet, a moisture flow rate detection means 23 detect the moisture flow rate which flows from the air-supply section 2, and a moisture flow rate detection means 24 detect the moisture flow rate which flows out of that of an air outlet have established. As these moisture flow rate detection means 21, 22, 23, and 24, it is possible to constitute, for example from a dew-point detection means and mass flow rate detection means, such as a mirror plane cooling type.
[0071] Moreover, in the control unit 11, a means to calculate the moisture content generated inside the fuel cell stack according to the current value taken out from the fuel cell stack 4 is established.
[0072] To the value which applied the moisture content generated inside the stack by the moisture flow rate sum total in the hydrogen of the inlet port of the fuel cell stack 4, and air, if the moisture flow rate sum total in the hydrogen of a fuel cell stack outlet and air is large, it is shown that having come out from the film into the gas of moisture is shown, namely, the film is in a desiccation inclination.
[0073] Conversely, if the moisture content sum total in the hydrogen of an outlet and air is small, it turns out that moisture will have permeated the film out of gas, namely, the film is in a humid inclination. Therefore, average humid extent in a fuel cell stack can be presumed now by integrating with the variation of this moisture.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention relates to the fuel cell which can be built over the fuel cell of a solid oxide type, and its operating method, especially can control the humidity of an electrode or an electrolyte membrane appropriately, and its operating method.

[Translation done.]

* NOTICES *

PRIOR ART

[Description of the Prior Art] The fuel cell technique attracts attention to the environmental problem in recent years, especially the problem of the global warming by the air pollution by exhaust gas and the carbon dioxide of an automobile as the power source which makes possible clean exhaust air and high energy efficiency, or a source of power.
[0003] The single cel of a fuel cell joins the electrode which includes a catalyst in the both sides of the electrolyte membrane which is an ion conductor, and is constituted. And fuel gas, oxidation gas, for example, the gas containing hydrogen, and air are supplied to two electrodes, respectively. In the anode (fuel electrode) to which hydrogen is supplied, hydrogen ionizes into a hydrogen ion and an electron. In an electron, return and a hydrogen ion arrive at an anode plate through an electrolyte membrane at a cathode (air pole) through an external circuit. In the cathode to which the oxygen in air is supplied, a hydrogen ion, oxygen, and an electron react and water is generated.
[0004] The stack structure which it usually accumulated two or more cels with about 1.2 V since the theoretical electromotive force of the single cel of a fuel cell was low, and was made into series connection is used. The solid-state polyelectrolyte mold fuel cell which has high power density especially also in a fuel cell attracts attention as sources for mobiles of power, such as an automobile.
[0005] In operation of such a fuel cell, an important point is keeping proper the damp or wet condition of an electrode catalyst and the solid-state polyelectrolyte film. If these tend to dry, ionic conductivity will fall and the internal resistance as a power plant will increase. If humidity passes with the generation water by the reaction of hydrogen and oxygen etc., the effective electrode surface product which incorporates gas will decrease, and the output current will decrease.
[0006] It considers as the technique which controls the damp or wet condition of the electrode in the conventional fuel cell, and the solid-state polyelectrolyte film proper, and the technique given in JP,7-22047,A is known. According to this conventional technique, the reference electrode in which the reference potential stabilized in the fuel cell is shown was prepared, the anode of a cel to this reference electrode and the potential of a cathode were measured, and the amount of humidification of fuel gas or oxidation gas was adjusted based on this potential.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] An electrical-potential-difference detection means to detect the electrical potential difference of at least two cels which were chosen from two or more cels which constitute a fuel cell stack according to invention according to claim 1, The humidity distribution means forming which forms relative humidity distribution of fuel gas and oxidation gas in the cel array direction of a fuel cell stack at least at the time of the cel electrical-potential-difference detection by said electrical-potential-difference detection means, Since the distribution of voltage for every cel which said electrical-potential-difference detection means detected was investigated, and the electrical potential difference of a cel with low relative humidity was equipped with a damp or wet condition judging means to judge with the humidity of a fuel cell being inadequate when low compared with the electrical potential difference of a cel with high relative humidity The effectiveness that it can judge correctly whether hydration or the moisture of the damp or wet condition of a fuel cell is insufficient based on the measurement result of the electrical potential difference of a cel with high relative humidity and the electrical potential difference of a cel with low relative humidity is done so. Moreover, since the judgment of a damp or wet condition becomes exact, an unnecessary hydrogen purge is reduced and the effectiveness of improving the fuel consumption of a fuel cell is done so.
[0023] According to invention according to claim 2, to an effect of the invention according to claim 1 in addition, said humidity distribution means forming While usually making the inflow direction and the cooling water inflow direction of a fuel cell stack of fuel gas and oxidation gas into this direction at the time of operation By changing to hard flow at the time of the electrical-potential-difference detection by said electrical-potential-difference detection means for the damp or wet condition judging by said damp or wet condition judging means Since it is a cooling means to form relative humidity distribution of fuel gas and oxidation gas in the cel array direction of a fuel cell stack Usually, the effectiveness that an exact damp or wet condition can be judged is done so, without forming relative humidity distribution of the both sides of relative humidity distribution suitable at the time of operation and relative humidity distribution suitable at the time of a damp or wet condition judging, and usually reducing the generating efficiency at the time of operation.
[0024] According to invention according to claim 3, to an effect of the invention

according to claim 1 in addition, said humidity distribution means forming Since the inflow direction and the cooling water inflow direction of a fuel cell stack of fuel gas and oxidation gas were always made into hard flow and it is a cooling means to form relative humidity distribution of fuel gas and oxidation gas in the cel array direction of a fuel cell stack The effectiveness that an exact damp or wet condition can be judged is done so, without preparing the cooling water inflow direction change function, and complicating a cooling means.

[0025] An electrical-potential-difference amperometry means to measure the electrical potential difference and current under fuel cell stack operation according to invention according to claim 4, An internal resistance presumption means to presume the internal resistance value of a fuel cell stack based on the volt ampere characteristic which this electrical-potential-difference amperometry means measured, The effectiveness that a damp or wet condition can be judged is done so, without forming relative humidity distribution in a fuel cell stack, since it had a damp or wet condition judging means to judge the damp or wet condition of a fuel cell, based on the comparison with the certified value beforehand remembered to be said presumed internal resistance value.

[0026] Since it had [according to invention according to claim 5] further a thermometry means to measure the temperature of a fuel cell, and a certified value modification means to change said certified value based on the measured temperature in addition to the effect of the invention according to claim 4, even if the operating temperature of a fuel cell has change, the effectiveness that an exact damp or wet condition judging can be performed is done so.

[0027] An influent daily dose detection means to detect the moisture content of the fuel gas which flows into a fuel cell stack, and oxidation gas according to invention according to claim 6, An effluent daily dose detection means to detect the moisture content of the fuel gas which flows out of a fuel cell stack, and oxidation gas, By having had a generation moisture content presumption means to presume the moisture content generated inside the fuel cell stack, and a damp or wet condition judging means to judge the damp or wet condition of a fuel cell based on said moisture content, influent daily dose, and effluent daily dose which were generated The change hysteresis of the moisture content inside a fuel cell stack is pursued correctly, and the effectiveness that the damp or wet condition of a fuel cell can be judged correctly is done so.

[0028] Since it had further a load limitation means to restrict the output of a fuel cell when it judged [according to invention according to claim 7] with said damp or wet condition judging means of humidity being inadequate in addition to claim 1 thru/or an effect of the invention according to claim 6, the effectiveness that recovery from dryness and continuation of operation of a fuel cell can be reconciled is done so.

[0029] According to invention according to claim 8, like the humidity distribution formation fault which forms relative humidity distribution of fuel gas and oxidation gas in the cel array direction of a fuel cell stack The electrical-potential-difference detection process in which the electrical potential difference of at least two cels chosen from two or more cels which constitute a fuel cell stack is detected, When the distribution of voltage for every cel was investigated, and low [compared with

the electrical potential difference of a cel with high relative humidity] and the electrical potential difference of a cel with low relative humidity judges with humidity being inadequate in the damp or wet condition judging process judged as the humidity of a fuel cell being inadequate, and said damp or wet condition judging process, Since it had the load limitation process in which the output of a fuel cell was restricted, the effectiveness that it can judge correctly whether hydration or the moisture of the damp or wet condition of a fuel cell is insufficient based on the measurement result of the electrical potential difference of a cel with high relative humidity and the electrical potential difference of a cel with low relative humidity is done so. Moreover, since the judgment of a damp or wet condition becomes exact, an unnecessary hydrogen purge is reduced and the effectiveness of improving the fuel consumption of a fuel cell is done so.

[0030] The electrical-potential-difference amperometry process which measures the electrical potential difference and current under fuel cell stack operation according to invention according to claim 9, The internal resistance presumption process in which the internal resistance value of a fuel cell stack is presumed based on said measured volt ampere characteristic, When it judges with humidity being inadequate based on the comparison with the certified value beforehand remembered to be said presumed internal resistance value in the damp or wet condition judging process in which the damp or wet condition of a fuel cell is judged, and said damp or wet condition judging process, The effectiveness that a damp or wet condition can be judged is done so, without forming relative humidity distribution in a fuel cell stack, since it had the load limitation process in which the output of a fuel cell was restricted. Moreover, since the judgment of a damp or wet condition becomes exact, an unnecessary hydrogen purge is reduced and the effectiveness of improving the fuel consumption of a fuel cell is done so.

[0031]

[Embodiment of the Invention] Next, the gestalt of operation of this invention is explained to a detail with reference to a drawing.

[1st operation gestalt] Drawing 1 is a whole block diagram explaining the configuration of the 1st operation gestalt of the fuel cell concerning this invention. The hydrogen feed zone 1 which supplies the gas (following and hydrogen content gas) by which a fuel cell contains the hydrogen as fuel gas by desired pressure and flow rate in drawing 1 , The air supply section 2 which supplies the air as oxidation gas by desired pressure and flow rate, The humidifier 3 which humidifies hydrogen content gas and air with the pure water supplied from the pure-water feeder which is not illustrated, respectively, The fuel cell stack 4 to which the hydrogen content gas and air which were humidified with the humidifier 3 are supplied, While cooling the pump 5 for fuel circulation to which recycling of the hydrogen which was not used is carried out, the check valve 6 which prevents the back flow of hydrogen content gas, and the fuel cell stack 4 At the time of the amplitude measurement for a damp or wet condition judging, it has the cooling system 12 which can make hard flow the inflow direction of the cooling water to the fuel cell stack 4 with the gas inflow direction to the fuel cell stack 4, and the control unit 11 which controls these equipments.

[0032] The electrical-potential-difference detector which are two or more cels

chosen from two or more cels which constitute a stack, and an electrical-potential-difference detection means to detect each electrical potential difference of all cels preferably and which is not illustrated is formed in the fuel cell stack 4, and the detecting signal of this electrical-potential-difference detector is told to it to a control unit 11.

[0033] A cooling system 12 is equipped with the cooling-water passage which was established in the interior of the fuel cell stack 4 and which is not illustrated, the cooling water pump 7 made to circulate through cooling water, the radiator or the radiator which radiates heat to the exterior in the heat of cooling water, and a radiator fan's group 8, the method valve 9 of four which reverses the direction of the cooling water which flows to the fuel cell stack 4, the thermometer 10 which measure a circulating water temperature, the duct which connect these, and the cooling water with which these interior was filled up.

[0034] And the cooling system 12 constitutes the humidity distribution means forming which forms relative humidity distribution of fuel gas and oxidation gas in the cel array direction of a fuel cell stack at the time of the cel electrical-potential-difference detection by the electrical-potential-difference detection means.

[0035] Moreover, while a control unit 11 receives the hydrogen feed zone 1, the air supply section 2, and the detecting signal from a thermometer 10, it sends out the control signal which controls the hydrogen feed zone 1, the air supply section 2, a cooling water pump 7, and the method valve 9 of four.

[0036] Next, an operation of the relative humidity distribution formation by the cooling system 12 is explained. After the hydrogen content gas and air which are supplied from the hydrogen feed zone 1 and the air supply section 2 pass a humidifier 3 and serve as suitable humidity, they are supplied from the drawing Nakamigi side of the fuel cell stack 4. It is thought that absolute humidity does not fall and absolute humidity goes up them rather since this hydrogen content gas and air are further humidified by the moisture which generates the interior of the fuel cell stack 4 by generation of electrical energy as it flows from the right to the left after they are humidified by a certain absolute humidity with a humidifier 3.

[0037] According to the control from a control unit 11, the method valve 9 of four which changes the direction of cooling water is usually changed so that cooling water may be poured in the direction of an arrow head of a broken line at the time of electrical-potential-difference detection according cooling water to a sink and an electrical-potential-difference detector to the direction of an arrow head of a continuous line in the time of operation. Since the cooling water which flows the fuel cell stack 4 by this usually flows from drawing Nakamigi to the left at the time of operation, the temperature distribution in the fuel cell stack 4 at this time have a low drawing Nakamigi side, and left-hand side becomes high.

[0038] On the other hand, since cooling water flows from ****** to the right contrary to the direction where gas flows at the time of the amplitude measurement for a damp or wet condition judging, the temperature distribution in the fuel cell stack 4 at this time usually have a high drawing Nakamigi side contrary to the time of operation, and left-hand side becomes low. Therefore, relative humidity distribution of the fuel cell stack 4 at the time of an amplitude

measurement has a low drawing Nakamigi side, and left-hand side becomes high.
[0039] Where such relative humidity distribution is formed, when each temperature of two or more cels of the fuel cell stack 4 is measured, according to the location of the measured cel, the electrical potential difference of a cel with low relative humidity and the electrical potential difference of a cel with high relative humidity will be measured.
[0040] In addition, relative humidity distribution may always be made to be formed in a fuel cell stack by making the gas inflow direction and cooling water close flow direction to a fuel cell stack into an opposite direction as a modification of the 1st operation gestalt, without usually changing the direction of cooling water in the time of operation and the amplitude measurement for a damp or wet condition judging. According to this modification, although it becomes the configuration which omits the method valve of four which changes the direction of cooling water, and is shown in drawing 2 , it is unavoidable that some falls usually arise in the generating efficiency at the time of operation.
[0041] Next, actuation of the 1st operation gestalt is explained with reference to the flow chart of drawing 3 . The current under fuel cell stack operation and detection of an electrical potential difference are first performed at step (a step is hereafter abbreviated to S) 101. Subsequently, in S102, it returns to S101 again, without carrying out the processing flow of this operation gestalt shown in less than [S103], if it judges whether sag is carried out and sag is not accepted from the current potential property of having memorized beforehand the combination of this detected current/electrical potential difference.
[0042] When sag is accepted, it supposes that it is necessary to judge the cause of sag with a sufficient precision that an electrical potential difference should be recovered appropriately, and with this operation gestalt, the method valve 9 of four is changed so that the circulation direction of cooling water may turn into the I/O direction to the fuel cell stack 4 of gas, such as hydrogen and air, to hard flow by S103. Of the change of this cooling water inflow direction, distribution of relative humidity is formed in the cel array direction as mentioned above in the fuel cell stack 4.
[0043] In addition, like the modification of the 1st operation gestalt shown in drawing 2 , the inflow direction of the cooling water to a fuel cell stack is always set as hard flow with the inflow direction of gas, and when it has composition which does not change the cooling water inflow direction, these S103 is omitted.
[0044] Moreover, when the existence of sag is judged and sag is judged, although [S102] below this step is performed, it is good also as a configuration which deletes S101 and S102 and performs processing not more than S103 periodically.
[0045] Subsequently, where distribution of relative humidity is formed in the cel array direction, an electrical-potential-difference detector detects the electrical potential difference of each cel which constitutes a fuel cell stack from S104, and a detection value is told to a control unit 11. Although the fuel cell stack 4 consists of two or more cels, it is more desirable to consider the cel electrical potential difference of these plurality as the configuration which can detect the value of the same time of day as much as possible.
[0046] Subsequently, in S105, the inclination of the cel electrical potential

difference by the location of each cel is judged, and it judges whether it is what the cause of sag depends on desiccation of the film by S106.

[0047] Although drawing 4 is an example of the cel distribution of voltage corresponding to each cel location, it is drawing which arranged the electrical potential difference of each cel in order, and expressed it toward the outlet side from the gas inlet side. When the inclination for it to apply to an outlet side from a gas inlet side, and for a cel electrical potential difference to become high like this drawing 4 is acquired, it will judge, if the film does not fully carry out humidity but is in dryness.

[0048] It is possible to judge that this means that the electrical potential difference of the cel of a part with low relative humidity is lower than the electrical potential difference of a cel with high relative humidity, namely, the film of the cel of a part with low relative humidity does not fully carry out humidity, but it causes [of the electrical potential difference] a fall.

[0049] Moreover, although it is the case where correlation is not looked at by distribution of relative humidity, and especially distribution of a cel electrical potential difference when cel distribution of voltage as shown in drawing 5 is acquired namely, it is judged that humidity of the film is fully carried out in this case. In the condition that there is no correlation in a cel electrical potential difference and relative humidity, though a cel electrical potential difference is lower than expected value, the film is not dry and you may judge it as what is depended on other causes, for example, the fall of a hydrogen partial pressure etc.

[0050] In addition, when distribution as shown in drawing 6 in this operation gestalt is acquired, it is the case where distribution which is low to the cel electrical potential difference of a part with the low relative humidity by the side of a gas outlet is acquired, but moisture accumulates in the cel of a part with high relative humidity in this case, and if the electrical potential difference is falling by reduction of reaction area, it can judge.

[0051] As mentioned above, when the cause of sag is judged to be what is depended on desiccation of the film, a fuel cell stack output is restricted and the upper limit in which an output request is possible is notified to the control means (not shown) of the high order which controls (S107-109), simultaneously orders it the output request of a fuel cell stack to the fuel cell control means 11 so that it may not become below the set point with a stack electrical potential difference.

[0052] Thereby, since the operation of a demand command value is attained recognizing the maximum of the power which a fuel cell stack can take out, the control means of a high order can prevent the condition of saying that it is not outputted unexpectedly.

[0053] In addition, the result of having presumed the membranous damp or wet condition like S104-S106 according to the inclination according to the location of each cel electrical potential difference may perform load limitation of a fuel cell stack.

[0054] Moreover, although it is the electrical potential difference of a fuel cell stack, and the control means of an output, it may connect with a fuel cell stack, a DC to DC converter with a current control function may be carried out, and, for details, it omits.

[0055] Moreover, when the cause of sag is except desiccation of the film, the block which performs processing corresponding to the cause is performed. For example, when nitrogen concentration goes up to a hydrogen pole side and the hydrogen partial pressure is falling as a result, it controls to raise a hydrogen partial pressure by purging a hydrogen pole (S110).
[0056] As an example, when hydrogen is the circulatory system, although a hydrogen pole purge is possible, since it is not the essence of this invention, it omits for details by discharging to the system exterior, without returning the exhausted hydrogen from a fuel cell stack, and increasing a hydrogen flow rate to coincidence.
[0057] [2nd operation gestalt] The configuration of this operation gestalt is the same as that of drawing 1 which shows the 1st operation gestalt. In addition, in this operation gestalt, since it is not necessary to necessarily make reverse the inflow direction of gas, and the inflow direction of cooling water, the method valve 9 of four is omissible.
[0058] The flow chart of this operation gestalt is shown in drawing 7 . This operation gestalt measures the current and electrical potential difference under operation of a fuel cell stack beyond a certain fixed time amount or more than the certain fixed number of samplings, calculates an internal resistance value from the measured current and an electrical potential difference, and presumes membranous dryness from the value.
[0059] It is equivalent to the inclination of the interstitial segment in the current-voltage characteristic indicated to be an internal resistance value here to drawing 10 (a). Ionic conductivity falls and it is observed in a form like increase of electric resistance as a membranous moisture content decreases.
[0060] namely, -- if humidity is carried out enough, will become the property (it considers as a standard property hereafter) which shows the highest electrical potential difference in drawing 10 (a), but the electrical potential difference when pulling out the same current value from a fuel cell stack falls, and the inclination of an abbreviation bay is sudden as it becomes with some desiccation -- becoming -- a result -- a form [like the lower left] whose current-voltage characteristic is -- changing -- ******** .
[0061] Moreover, although the inclination of this abbreviation bay is the same as it of a standard property, when beyond a certain current value is taken out and the fall of an electrical potential difference is accepted rapidly (drawing 10 (b)), the membranous damp or wet condition is suitable, but to the current which the condition (a flow rate and pressure) of gas took out, if not suitable, it will judge.
[0062] Moreover, it can be judged that it becomes the volt ampere characteristic when the condition of drawing 10 (a) and drawing 10 (b) occurs in coincidence, as shown in drawing 10 (c), and membranous humidity is liable to insufficient, and the condition of gas is not suitable when the inclination of an abbreviation bay is more sudden than a standard property, and beyond a certain current value is taken out, a property separates from a straight line and an electrical potential difference falls.

[0063] The flow chart of drawing 7 which asks below for internal resistance based on the volt ampere characteristic measured during operation of a fuel cell stack is

explained.
[0064] The current and electrical potential difference of a fuel cell stack of **** time of day are first detected by S201. This time of day of this timing is as much as possible more desirable. Subsequently, in S202, data are filtered with the value of the detected current. Since the effect of internal resistance has not come out of the property in the minimum current region, this is for cutting the data of such a field. In S203, in order to refer to by the internal resistance operation mentioned later, the measured current and the group data of an electrical potential difference are recorded on a record means.
[0065] In S204, the recorded current and the group data of an electrical potential difference judge whether it is sufficient thing for internal resistance calculation. It may be recorded beyond the set point that has that current values are scattered enough broadly and the number of group data as conditions judge that are enough. In S205, internal resistance is actually calculated. Two or more currents and the group data of an electrical potential difference are approximated in a straight line, and, specifically, it asks for them from the slope of a line.
[0066] In addition, about the approach of approximating the group data of two or more current/electrical potential differences in a straight line, there are the least square method which asks for the approximation straight line from which the sum total of the square of the distance from the point which shows class data to an approximation straight line serves as min, an approach shown in JP,6-174808,A.
[0067] The inclination of the abbreviation bay for which it asked by the above approaches is compared with the standard property beforehand searched for in the experiment etc., when an inclination is sudden, it judges that the film is dry, and it processes restricting an output etc., and it becomes possible to stop bad influences, such as degradation of a stack. moreover, the inclination of an abbreviation bay -- it of a standard property, and abbreviation -- it is the same, and the nitrogen accumulated in the hydrogen pole by performing purge processing is discharged, a hydrogen partial pressure is recovered [it supposes that a problem is in gas conditions when the fall of an electrical potential difference is accepted in beyond a certain current value, and], and it becomes possible to return to the standard property of an electrical potential difference.
[0068] In addition, since the internal resistance of a fuel cell has the temperature characteristics, such as resistance of an electrode, and electrolytic ion conductivity, it is desirable to change the certified value of internal resistance according to the measurement result of the thermometer 10 which measures cooling water temperature, for example. The map for which it specifically asked experimentally, and an amendment formula are used.
[0069] [3rd operation gestalt] Drawing 8 is the whole block diagram showing the configuration of the 3rd operation gestalt of the fuel cell concerning this invention. This operation gestalt is the example which deleted the method valve 9 of four, made the cooling water inflow direction to the fuel cell stack 4 always the same as that of the gas inflow direction to the 1st operation gestalt shown in drawing 1 , and formed the moisture flow rate detection means in hydrogen content gas and the fuel cell stack I/O section of air.
[0070] That is, a moisture flow rate detection means 21 detect the moisture flow

rate which flows into the fuel cell stack 4 from the hydrogen feed zone 1, a moisture flow rate detection means 22 detect the moisture flow rate which flows out of a hydrogen outlet, a moisture flow rate detection means 23 detect the moisture flow rate which flows from the air-supply section 2, and a moisture flow rate detection means 24 detect the moisture flow rate which flows out of that of an air outlet have established. As these moisture flow rate detection means 21, 22, 23, and 24, it is possible to constitute, for example from a dew-point detection means and mass flow rate detection means, such as a mirror plane cooling type.

[0071] Moreover, in the control unit 11, a means to calculate the moisture content generated inside the fuel cell stack according to the current value taken out from the fuel cell stack 4 is established.

[0072] To the value which applied the moisture content generated inside the stack by the moisture flow rate sum total in the hydrogen of the inlet port of the fuel cell stack 4, and air, if the moisture flow rate sum total in the hydrogen of a fuel cell stack outlet and air is large, it is shown that having come out from the film into the gas of moisture is shown, namely, the film is in a desiccation inclination.

[0073] Conversely, if the moisture content sum total in the hydrogen of an outlet and air is small, it turns out that moisture will have permeated the film out of gas, namely, the film is in a humid inclination. Therefore, average humid extent in a fuel cell stack can be presumed now by integrating with the variation of this moisture.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, since the above-mentioned conventional technique had become the configuration of measuring the potential of the anode to the reference electrode in a fuel cell, and a cathode, there was a trouble that application was impossible in the fuel cell which does not have the reference electrode.
[0008] Moreover, since the above-mentioned conventional technique had become the configuration of judging the excess of moisture, or desiccation of the film, by change of the anode to the output current, and cathode potential, when the above output current was not pulled out to some extent, a unique reaction was not seen but it had the trouble that the judgment of a damp or wet condition was difficult.
[0009] Furthermore, since both the excess of moisture and desiccation of the film may become a cause when the singularity of potential change is accepted in an anode and cathode two poles, the above-mentioned conventional technique requires time amount for both distinction. It was specifically once made dryness, and after measuring the potential change, since both distinction was judged, the trouble that immediate output recovery was difficult was for the first time.
[0010] It is offering the fuel cell which detects a damp or wet condition and can control operation, and its operating method, without the purpose of this invention preparing a reference electrode in each cel of a fuel cell in view of the above trouble.
[0011] Moreover, especially the purpose of this invention is offering the fuel cell which can judge a damp or wet condition easily, and its operating method, without pulling out the output current of a fuel cell.
[0012] Furthermore, the purpose of this invention is offering the fuel cell which can judge easily whether it having changed in hydration or which direction of desiccation from the proper damp or wet condition, and its operating method.

[Translation done.]

MEANS

[Means for Solving the Problem] An electrical-potential-difference detection means to detect the electrical potential difference of at least two cels chosen from two or more cels which constitute a fuel cell stack in order that invention according to claim 1 might solve the above-mentioned technical problem, The humidity distribution means forming which forms relative humidity distribution of fuel gas and oxidation gas in the cel array direction of a fuel cell stack at least at the time of the cel electrical-potential-difference detection by the electrical-potential-difference detection means, Relative humidity is the fuel cell which makes it a summary to have investigated the distribution of voltage for every cel which the electrical-potential-difference detection means detected, and to have had a damp or wet condition judging means to judge with the humidity of a fuel cell being inadequate when low compared with the electrical potential difference of a cel with the high electrical potential difference of a cel with low relative humidity.
[0014] Invention according to claim 2 is set to a fuel cell according to claim 1 in order to solve the above-mentioned technical problem. Said humidity distribution means forming While usually making the inflow direction and the cooling water inflow direction of a fuel cell stack of fuel gas and oxidation gas into this direction at the time of operation Let it be a summary to be a cooling means to form relative humidity distribution of fuel gas and oxidation gas in the cel array direction of a fuel cell stack by changing to hard flow at the time of the electrical-potential-difference detection by said electrical-potential-difference detection means for the damp or wet condition judging by said damp or wet condition judging means.
[0015] In order that invention according to claim 3 may solve the above-mentioned technical problem, in a fuel cell according to claim 1, said humidity distribution means forming always makes hard flow the inflow direction and the cooling water inflow direction of a fuel cell stack of fuel gas and oxidation gas, and makes it a summary to be a cooling means to form relative humidity distribution of fuel gas and oxidation gas in the cel array direction of a fuel cell stack.
[0016] An electrical-potential-difference amperometry means to measure the electrical potential difference and current under fuel cell stack operation in order that invention according to claim 4 may solve the above-mentioned technical problem, An internal resistance presumption means to presume the internal resistance value of a fuel cell stack based on the volt ampere characteristic which this electrical-potential-difference amperometry means measured, It is the fuel cell

which makes it a summary to have had a damp or wet condition judging means to judge the damp or wet condition of a fuel cell, based on the comparison with the certified value beforehand remembered to be this presumed internal resistance value.
[0017] Invention according to claim 5 makes it a summary to have had further a thermometry means to measure the temperature of a fuel cell, and a certified value modification means to change said certified value based on the measured temperature in a fuel cell according to claim 4 in order to solve the above-mentioned technical problem.
[0018] An influent daily dose detection means to detect the moisture content of the fuel gas which flows into a fuel cell stack, and oxidation gas in order that invention according to claim 6 may solve the above-mentioned technical problem, An effluent daily dose detection means to detect the moisture content of the fuel gas which flows out of a fuel cell stack, and oxidation gas, It is the fuel cell which makes it a summary to have had a generation moisture content presumption means to presume the moisture content generated inside the fuel cell stack, and a damp or wet condition judging means to judge the damp or wet condition of a fuel cell based on said moisture content, influent daily dose, and effluent daily dose which were generated.
[0019] When it judges with said damp or wet condition judging means of humidity being inadequate in the fuel cell of claim 1 thru/or claim 6 given in any 1 term, invention according to claim 7 makes it a summary to have had further a load limitation means to restrict the output of a fuel cell, in order to solve the above-mentioned technical problem.
[0020] Invention according to claim 8 like the humidity distribution formation fault which forms relative humidity distribution of fuel gas and oxidation gas in the cel array direction of a fuel cell stack in order to solve the above-mentioned technical problem The electrical-potential-difference detection process in which the electrical potential difference of at least two cels chosen from two or more cels which constitute a fuel cell stack is detected, When the distribution of voltage for every cel was investigated, and low [compared with the electrical potential difference of a cel with high relative humidity] and the electrical potential difference of a cel with low relative humidity judges with humidity being inadequate in the damp or wet condition judging process judged as the humidity of a fuel cell being inadequate, and this damp or wet condition judging process, It is the operating method of the fuel cell which makes it a summary to have had the load limitation process in which the output of a fuel cell was restricted.
[0021] The electrical-potential-difference amperometry process which measures the electrical potential difference and current under fuel cell stack operation in order that invention according to claim 9 may solve the above-mentioned technical problem, The internal resistance presumption process in which the internal resistance value of a fuel cell stack is presumed based on this measured volt ampere characteristic, When it judges with humidity being inadequate based on the comparison with the certified value beforehand remembered to be this presumed internal resistance value in the damp or wet condition judging process in which the damp or wet condition of a fuel cell is judged, and this damp or wet condition

judging process, It is the operating method of the fuel cell which makes it a summary to have had the load limitation process in which the output of a fuel cell was restricted.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the whole block diagram showing the configuration of the 1st operation gestalt of the fuel cell concerning this invention.
[Drawing 2] It is the whole block diagram showing the configuration of the modification of the 1st operation gestalt.
[Drawing 3] It is a flow chart explaining actuation of the 1st operation gestalt.
[Drawing 4] It is drawing showing the example of cel distribution of voltage over the cel location in an inadequate damp or wet condition.
[Drawing 5] It is drawing showing the example of cel distribution of voltage over the cel location in a moderate damp or wet condition.
[Drawing 6] It is drawing showing the example of cel distribution of voltage over the cel location in a superfluous damp or wet condition.
[Drawing 7] It is a flow chart explaining actuation of the 2nd operation gestalt.
[Drawing 8] It is the whole block diagram showing the configuration of the 3rd operation gestalt of the fuel cell concerning this invention.
[Drawing 9] (a) When the moisture in the film decreases and (b) hydrogen partial pressure falls, it is drawing which is the case where a hydrogen partial pressure falls after the moisture in (c) film had decreased and in which showing the example of representation of the current-voltage characteristic of a fuel cell, respectively.
[Description of Notations]
1 Hydrogen Feed Zone
2 Air Supply Section
3 Humidifier
4 Fuel Cell Stack
5 Pump for Fuel Circulation
6 Check Valve
7 Cooling Water Pump
8 Radiator
9 Method Valve of Four
10 Thermometer
11 Control Unit
12 Cooling System

[Translation done.]

* NOTICES *

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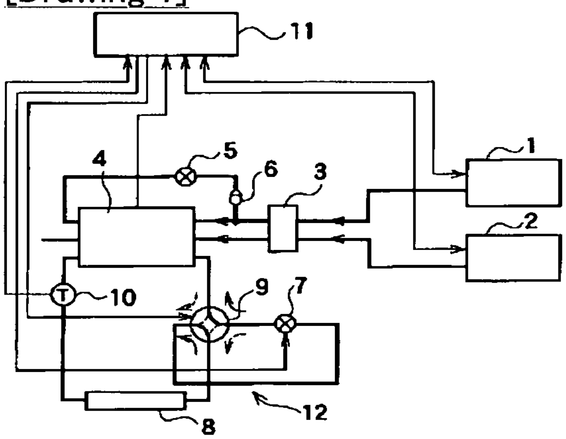
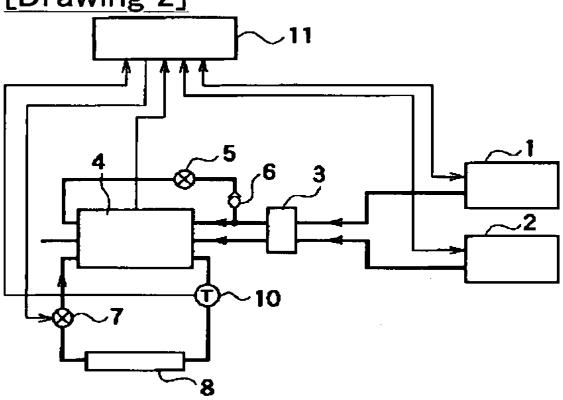
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

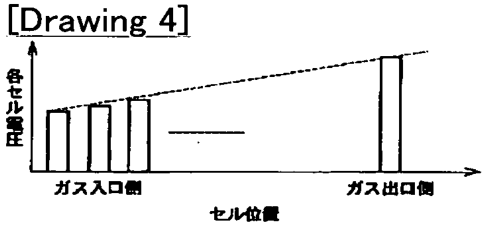
[Drawing 1]



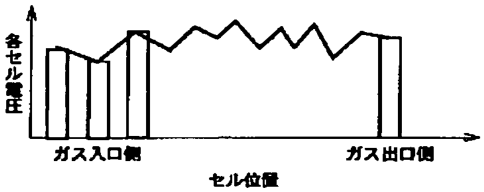
[Drawing 2]



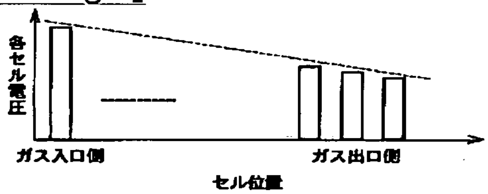
[Drawing 4]



[Drawing 5]



[Drawing 6]



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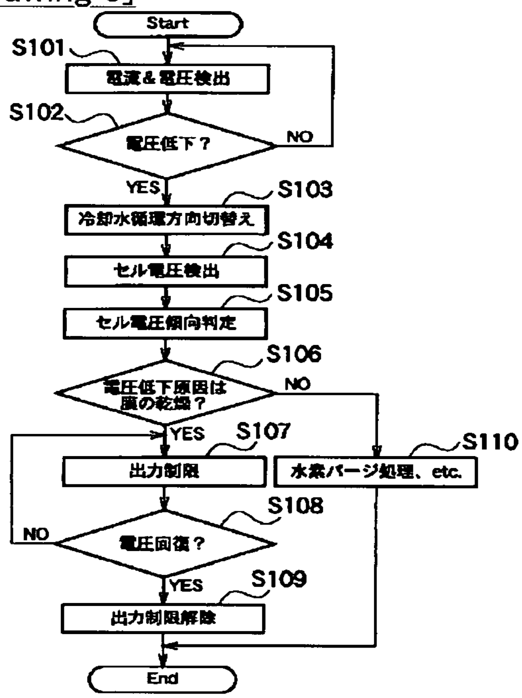
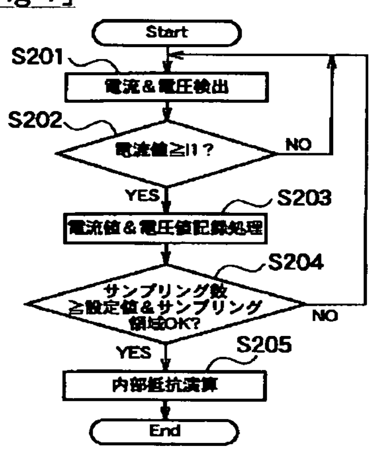
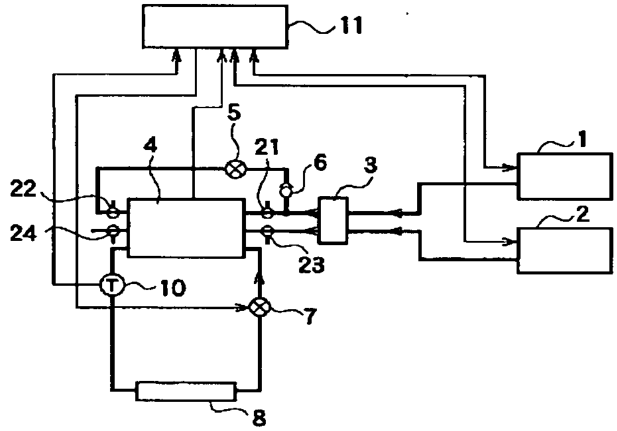


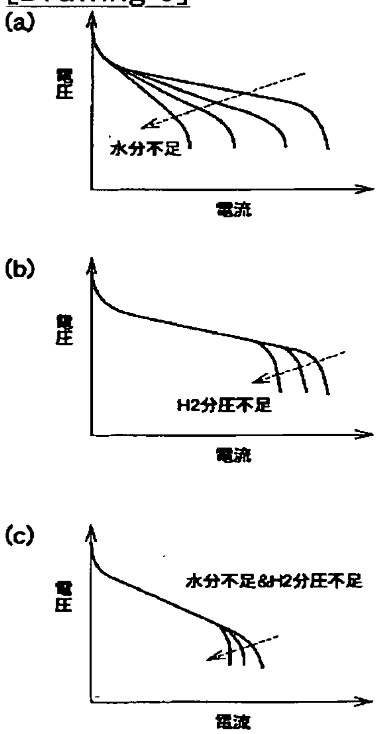
[Drawing 7]



[Drawing 8]



[Drawing 9]



[Translation done.]

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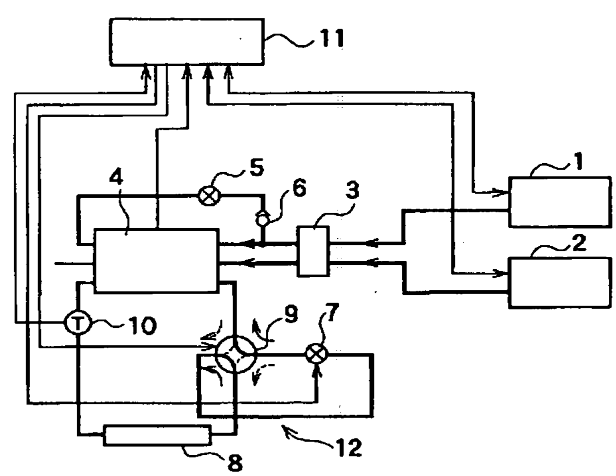
5H027 AA06 CC06 KK31 KK46 KK54 KK56 MM16 MM26

(54)【発明の名称】　燃料電池及びその運転方法

(57)【要約】

【課題】　燃料電池の各セルに参照電極を設けることなく、湿潤状態を検出して運転を制御する。

【解決手段】　燃料電池スタック４には加湿器３で加湿された水素含有ガス及び空気が図中右側から供給される。冷却水を循環させる冷却水ポンプ７、冷却水の熱を外部へ放熱するラジエータまたはラジエータとラジエータファンの組８、燃料電池スタック４に流れる冷却水の方向を反転させる４方弁９、及び冷却水温度を測定する温度計１０は冷却系１２を構成する。冷却系１２は、湿潤状態を判定するためのセル電圧測定時には左側から燃料電池スタック４へ冷却水を流入させ、セル配列方向に相対湿度分布を形成する。制御装置１１は、相対湿度の低いセルと高いセルとのセル電圧分布により、湿潤状態を判定する。



【特許請求の範囲】

【請求項１】　燃料電池スタックを構成する複数のセルから選ばれた少なくとも２つのセルの電圧を検出する電圧検出手段と、
少なくとも前記電圧検出手段によるセル電圧検出時に、燃料電池スタックのセル配列方向に燃料ガス及び酸化ガスの相対湿度分布を形成する湿度分布形成手段と、
前記電圧検出手段が検出した各セル毎の電圧分布を調べて、相対湿度が低いセルの電圧が相対湿度が高いセルの電圧に比べて低い場合に、燃料電池の湿潤が不十分と判定する湿潤状態判定手段と、
を備えたことを特徴とする燃料電池。

【請求項２】　前記湿度分布形成手段は、
燃料ガス及び酸化ガスの燃料電池スタックへの流入方向と冷却水流入方向とを通常運転時には同方向とする一方、前記湿潤状態判定手段による湿潤状態判定のための前記電圧検出手段による電圧検出時には逆方向に切り替えることで、燃料電池スタックのセル配列方向に燃料ガス及び酸化ガスの相対湿度分布を形成する冷却手段であることを特徴とする請求項１記載の燃料電池。

【請求項３】　前記湿度分布形成手段は、
燃料ガス及び酸化ガスの燃料電池スタックへの流入方向と冷却水流入方向とを常に逆方向とし、燃料電池スタックのセル配列方向に燃料ガス及び酸化ガスの相対湿度分布を形成する冷却手段であることを特徴とする請求項１記載の燃料電池。

【請求項４】　燃料電池スタック運転中の電圧と電流とを測定する電圧電流測定手段と、
該電圧電流測定手段が測定した電圧電流特性に基づいて、燃料電池スタックの内部抵抗値を推定する内部抵抗推定手段と、
前記推定された内部抵抗値と予め記憶した標準値との比較に基づいて、燃料電池の湿潤状態を判定する湿潤状態判定手段と、
該湿潤状態判定手段が湿潤が不十分と判定したとき、燃料電池の出力を制限する出力制限手段と、
を備えたことを特徴とする燃料電池。

【請求項５】　燃料電池の温度を測定する温度測定手段と、
測定された温度に基づいて前記標準値を変更する標準値変更手段と、
を更に備えたことを特徴とする請求項４記載の燃料電池。

【請求項６】　燃料電池スタックへ流入する燃料ガス及び酸化ガスの水分量を検出する流入水分量検出手段と、
燃料電池スタックから流出する燃料ガス及び酸化ガスの水分量を検出する流出水分量検出手段と、
燃料電池スタック内部で生成された水分量を推定する生成水分量推定手段と、
前記生成された水分量及び流入水分量及び流出水分量に基づいて燃料電池の湿潤状態を判定する湿潤状態判定手段と、
を備えたことを特徴とする燃料電池。

【請求項７】　前記湿潤状態判定手段が湿潤が不十分と判定したとき、燃料電池の出力を制限する出力制限手段を更に備えたことを特徴とする請求項１ないし請求項６のいずれか１項記載の燃料電池。

【請求項８】　燃料電池スタックのセル配列方向に燃料ガス及び酸化ガスの相対湿度分布を形成する湿度分布形成過程と、
燃料電池スタックを構成する複数のセルから選ばれた少なくとも２つのセルの電圧を検出する電圧検出過程と、
各セル毎の電圧分布を調べて、相対湿度が低いセルの電圧が相対湿度が高いセルの電圧に比べて低い場合に、燃料電池の湿潤が不十分と判定する湿潤状態判定過程と、
前記湿潤状態判定過程で湿潤が不十分と判定したとき、燃料電池の出力を制限する出力制限過程と、
を備えたことを特徴とする燃料電池の運転方法。

【請求項９】　燃料電池スタック運転中の電圧と電流とを測定する電圧電流測定過程と、
前記測定された電圧電流特性に基づいて、燃料電池スタックの内部抵抗値を推定する内部抵抗推定過程と、
前記推定された内部抵抗値と予め記憶した標準値との比較に基づいて、燃料電池の湿潤状態を判定する湿潤状態判定過程と、
前記湿潤状態判定過程で湿潤が不十分と判定したとき、燃料電池の出力を制限する出力制限過程と、
を備えたことを特徴とする燃料電池の運転方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、固体電解質型の燃料電池及びその運転方法に係り、特に電極や電解質膜の湿度を適切に制御することができる燃料電池及びその運転方法に関する。

【０００２】

【従来の技術】近年の環境問題、特に自動車の排気ガスによる大気汚染や二酸化炭素による地球温暖化の問題に対して、クリーンな排気及び高いエネルギー効率を可能とする電力源、あるいは動力源として、燃料電池技術が注目されている。

【０００３】燃料電池の単セルは、イオン伝導体である電解質膜の両側に触媒を含む電極を接合して構成される。そして２つの電極にそれぞれ燃料ガスと酸化ガス、例えば水素を含むガスと空気とを供給する。水素が供給されるアノード（燃料極）では、水素が水素イオンと電子とに電離する。電子は外部回路を通って陽極に戻り、水素イオンは電解質膜を通ってカソード（空気極）に達する。空気中の酸素が供給されるカソードでは、水素イオンと酸素と電子とが反応して水が生成される。

【０００４】燃料電池の単セルの理論的な起電力は、約

１．２Ｖと低いので、通常複数セルを積み重ねて直列接続としたスタック構造が用いられる。燃料電池の中でも特に高い出力密度を有する固体高分子電解質型燃料電池が自動車等の移動体用動力源として注目されている。

【０００５】このような燃料電池の運転において重要な点は、電極触媒及び固体高分子電解質膜の湿潤状態を適正に保つことである。これらが乾燥気味であれば、イオン伝導度が低下し、発電装置としての内部抵抗が増加する。水素と酸素との反応による生成水等により湿潤が過ぎれば、ガスを取り込む有効電極面積が減少して出力電流が減少する。

【０００６】従来の燃料電池における電極及び固体高分子電解質膜の湿潤状態を適正に制御する技術として、特開平７－２２０４７号公報記載の技術が知られている。この従来技術によれば、燃料電池内に安定した基準電位を示す参照電極を設け、この参照電極に対するセルのアノード及びカソードの電位を測定し、この電位に基づいて燃料ガスまたは酸化ガスの加湿量を調節していた。

【０００７】

【発明が解決しようとする課題】しかしながら、上記従来技術は、燃料電池内の参照電極に対するアノード及びカソードの電位を測定するという構成になっていたため、参照電極を有していない燃料電池には適用ができないという問題点があった。

【０００８】また、上記従来技術は、出力電流に対するアノード及びカソード電位の変化により、水分の過剰あるいは膜の乾燥を判定するという構成になっていたため、ある程度以上の出力電流を引き出さないと、特異な反応が見られず、湿潤状態の判定が困難であるという問題点があった。

【０００９】さらに、上記従来技術は、アノード及びカソード両極に電位変化の特異性が認められた時、水分の過剰及び膜の乾燥の両方が原因となる可能性があるため、両者の区別に時間がかかる。具体的には一度乾燥状態にし、その電位変化を測定した後に初めて、両者の区別が判定できるため、早急な出力回復が困難であるという問題点があった。

【００１０】以上の問題点に鑑み本発明の目的は、燃料電池の各セルに参照電極を設けることなく、湿潤状態を検出して運転を制御できる燃料電池及びその運転方法を提供することである。

【００１１】また本発明の目的は、特に燃料電池の出力電流を引き出すことなく、湿潤状態の判定が容易に行える燃料電池及びその運転方法を提供することである。

【００１２】さらに本発明の目的は、適正な湿潤状態から水分過剰または乾燥のいずれの方向に変移したかを容易に判定することができる燃料電池及びその運転方法を提供することである。

【００１３】

【課題を解決するための手段】請求項１記載の発明は、上記課題を解決するため、燃料電池スタックを構成する複数のセルから選ばれた少なくとも２つのセルの電圧を検出する電圧検出手段と、少なくとも電圧検出手段によるセル電圧検出時に、燃料電池スタックのセル配列方向に燃料ガス及び酸化ガスの相対湿度分布を形成する湿度分布形成手段と、電圧検出手段が検出した各セル毎の電圧分布を調べて、相対湿度が低いセルの電圧が相対湿度が高いセルの電圧に比べて低い場合に、燃料電池の湿潤が不十分と判定する湿潤状態判定手段と、を備えたことを要旨とする燃料電池である。

【００１４】請求項２記載の発明は、上記課題を解決するため、請求項１記載の燃料電池において、前記湿度分布形成手段は、燃料ガス及び酸化ガスの燃料電池スタックへの流入方向と冷却水流入方向とを通常運転時には同方向とする一方、前記湿潤状態判定手段による湿潤状態判定のための前記電圧検出手段による電圧検出時には逆方向に切り替えることで、燃料電池スタックのセル配列方向に燃料ガス及び酸化ガスの相対湿度分布を形成する冷却手段であることを要旨とする。

【００１５】請求項３記載の発明は、上記課題を解決するため、請求項１記載の燃料電池において、前記湿度分布形成手段は、燃料ガス及び酸化ガスの燃料電池スタックへの流入方向と冷却水流入方向とを常に逆方向とし、燃料電池スタックのセル配列方向に燃料ガス及び酸化ガスの相対湿度分布を形成する冷却手段であることを要旨とする。

【００１６】請求項４記載の発明は、上記課題を解決するため、燃料電池スタック運転中の電圧と電流とを測定する電圧電流測定手段と、この電圧電流測定手段が測定した電圧電流特性に基づいて、燃料電池スタックの内部抵抗値を推定する内部抵抗推定手段と、この推定された内部抵抗値と予め記憶した標準値との比較に基づいて、燃料電池の湿潤状態を判定する湿潤状態判定手段と、を備えたことを要旨とする燃料電池である。

【００１７】請求項５記載の発明は、上記課題を解決するため、請求項４記載の燃料電池において、燃料電池の温度を測定する温度測定手段と、測定された温度に基づいて前記標準値を変更する標準値変更手段と、を更に備えたことを要旨とする。

【００１８】請求項６記載の発明は、上記課題を解決するため、燃料電池スタックへ流入する燃料ガス及び酸化ガスの水分量を検出する流入水分量検出手段と、燃料電池スタックから流出する燃料ガス及び酸化ガスの水分量を検出する流出水分量検出手段と、燃料電池スタック内部で生成された水分量を推定する生成水分量推定手段と、前記生成された水分量及び流入水分量及び流出水分量に基づいて燃料電池の湿潤状態を判定する湿潤状態判定手段と、を備えたことを要旨とする燃料電池である。

【００１９】請求項７記載の発明は、上記課題を解決するため、請求項１ないし請求項６のいずれか１項記載の

燃料電池において、前記湿潤状態判定手段が湿潤が不十分と判定したとき、燃料電池の出力を制限する出力制限手段を更に備えたことを要旨とする。

【００２０】請求項８記載の発明は、上記課題を解決するため、燃料電池スタックのセル配列方向に燃料ガス及び酸化ガスの相対湿度分布を形成する湿度分布形成過程と、燃料電池スタックを構成する複数のセルから選ばれた少なくとも２つのセルの電圧を検出する電圧検出過程と、各セル毎の電圧分布を調べて、相対湿度が低いセルの電圧が相対湿度が高いセルの電圧に比べて低い場合に、燃料電池の湿潤が不十分と判定する湿潤状態判定過程と、この湿潤状態判定過程で湿潤が不十分と判定したとき、燃料電池の出力を制限する出力制限過程と、を備えたことを要旨とする燃料電池の運転方法である。

【００２１】請求項９記載の発明は、上記課題を解決するため、燃料電池スタック運転中の電圧と電流とを測定する電圧電流測定過程と、この測定された電圧電流特性に基づいて、燃料電池スタックの内部抵抗値を推定する内部抵抗推定過程と、この推定された内部抵抗値と予め記憶した標準値との比較に基づいて、燃料電池の湿潤状態を判定する湿潤状態判定過程と、この湿潤状態判定過程で湿潤が不十分と判定したとき、燃料電池の出力を制限する出力制限過程と、を備えたことを要旨とする燃料電池の運転方法である。

【００２２】

【発明の効果】請求項１記載の発明によれば、燃料電池スタックを構成する複数のセルから選ばれた少なくとも２つのセルの電圧を検出する電圧検出手段と、少なくとも前記電圧検出手段によるセル電圧検出時に、燃料電池スタックのセル配列方向に燃料ガス及び酸化ガスの相対湿度分布を形成する湿度分布形成手段と、前記電圧検出手段が検出した各セル毎の電圧分布を調べて、相対湿度が低いセルの電圧が相対湿度が高いセルの電圧に比べて低い場合に、燃料電池の湿潤が不十分と判定する湿潤状態判定手段と、を備えたので、相対湿度が高いセルの電圧と相対湿度の低いセルの電圧の測定結果に基づいて燃料電池の湿潤状態が水分過剰か水分不足かを正確に判定することができるという効果を奏する。また湿潤状態の判定が正確になるので、不要な水素パージを低減し、燃料電池の燃費を向上するという効果を奏する。

【００２３】請求項２記載の発明によれば、請求項１記載の発明の効果に加えて、前記湿度分布形成手段は、燃料ガス及び酸化ガスの燃料電池スタックへの流入方向と冷却水流入方向とを通常運転時には同方向とする一方、前記湿潤状態判定手段による湿潤状態判定のための前記電圧検出手段による電圧検出時には逆方向に切り替えることで、燃料電池スタックのセル配列方向に燃料ガス及び酸化ガスの相対湿度分布を形成する冷却手段であるとしたので、通常運転時に好適な相対湿度分布と湿潤状態判定時に好適な相対湿度分布との双方の相対湿度分布を形成し、通常運転時の発電効率を低下させることなく、正確な湿潤状態の判定を行うことができるという効果を奏する。

【００２４】請求項３記載の発明によれば、請求項１記載の発明の効果に加えて、前記湿度分布形成手段は、燃料ガス及び酸化ガスの燃料電池スタックへの流入方向と冷却水流入方向とを常に逆方向とし、燃料電池スタックのセル配列方向に燃料ガス及び酸化ガスの相対湿度分布を形成する冷却手段であるとしたので、冷却水流入方向切り替え機能を設けて冷却手段を複雑にすることなく、正確な湿潤状態の判定を行うことができるという効果を奏する。

【００２５】請求項４記載の発明によれば、燃料電池スタック運転中の電圧と電流とを測定する電圧電流測定手段と、該電圧電流測定手段が測定した電圧電流特性に基づいて、燃料電池スタックの内部抵抗値を推定する内部抵抗推定手段と、前記推定された内部抵抗値と予め記憶した標準値との比較に基づいて、燃料電池の湿潤状態を判定する湿潤状態判定手段と、を備えたので、燃料電池スタックに相対湿度分布を形成することなく、湿潤状態を判定することができるという効果を奏する。

【００２６】請求項５記載の発明によれば、請求項４記載の発明の効果に加えて、燃料電池の温度を測定する温度測定手段と、測定された温度に基づいて前記標準値を変更する標準値変更手段と、を更に備えたので、燃料電池の運転温度に変化があっても正確な湿潤状態判定を行うことができるという効果を奏する。

【００２７】請求項６記載の発明によれば、燃料電池スタックへ流入する燃料ガス及び酸化ガスの水分量を検出する流入水分量検出手段と、燃料電池スタックから流出する燃料ガス及び酸化ガスの水分量を検出する流出水分量検出手段と、燃料電池スタック内部で生成された水分量を推定する生成水分量推定手段と、前記生成された水分量及び流入水分量及び流出水分量に基づいて燃料電池の湿潤状態を判定する湿潤状態判定手段と、を備えたことにより、燃料電池スタック内部の水分量の変化履歴を正確に追跡し、燃料電池の湿潤状態を正確に判定することができるという効果を奏する。

【００２８】請求項７記載の発明によれば、請求項１ないし請求項６記載の発明の効果に加えて、前記湿潤状態判定手段が湿潤が不十分と判定したとき、燃料電池の出力を制限する出力制限手段を更に備えたので、燃料電池の乾燥状態からの回復と運転継続とを両立させることができるという効果を奏する。

【００２９】請求項８記載の発明によれば、燃料電池スタックのセル配列方向に燃料ガス及び酸化ガスの相対湿度分布を形成する湿度分布形成過程と、燃料電池スタックを構成する複数のセルから選ばれた少なくとも２つのセルの電圧を検出する電圧検出過程と、各セル毎の電圧分布を調べて、相対湿度が低いセルの電圧が相対湿度が

高いセルの電圧に比べて低い場合に、燃料電池の湿潤が不十分と判定する湿潤状態判定過程と、前記湿潤状態判定過程で湿潤が不十分と判定したとき、燃料電池の出力を制限する出力制限過程と、を備えたので、相対湿度が高いセルの電圧と相対湿度の低いセルの電圧の測定結果に基づいて燃料電池の湿潤状態が水分過剰か水分不足かを正確に判定することができるという効果を奏する。また湿潤状態の判定が正確になるので、不要な水素パージを低減し、燃料電池の燃費を向上するという効果を奏する。

【００３０】請求項９記載の発明によれば、燃料電池スタック運転中の電圧と電流とを測定する電圧電流測定過程と、前記測定された電圧電流特性に基づいて、燃料電池スタックの内部抵抗値を推定する内部抵抗推定過程と、前記推定された内部抵抗値と予め記憶した標準値との比較に基づいて、燃料電池の湿潤状態を判定する湿潤状態判定過程と、前記湿潤状態判定過程で湿潤が不十分と判定したとき、燃料電池の出力を制限する出力制限過程と、を備えたので、燃料電池スタックに相対湿度分布を形成することなく、湿潤状態を判定することができるという効果を奏する。また湿潤状態の判定が正確になるので、不要な水素パージを低減し、燃料電池の燃費を向上するという効果を奏する。

【００３１】

【発明の実施の形態】次に、図面を参照して、本発明の実施の形態を詳細に説明する。

〔第１の実施形態〕図１は、本発明に係る燃料電池の第１の実施形態の構成を説明する全体構成図である。図１において、燃料電池は、燃料ガスとしての水素を含むガス（以下、水素含有ガス）を所望の圧力・流量で供給する水素供給部１と、酸化ガスとしての空気を所望の圧力・流量で供給する空気供給部２と、図示しない純水供給器から供給される純水で水素含有ガスと空気とをそれぞれ加湿する加湿器３と、加湿器３で加湿された水素含有ガス及び空気が供給される燃料電池スタック４と、使用されなかった水素を再循環させる燃料循環用ポンプ５と、水素含有ガスの逆流を防止する逆止弁６と、燃料電池スタック４を冷却するとともに、湿潤状態判定のための電圧測定時には燃料電池スタック４への冷却水の流入方向を燃料電池スタック４へのガス流入方向とは逆方向とすることができる冷却系１２と、これらの装置を制御する制御装置１１とを備えている。

【００３２】燃料電池スタック４には、スタックを構成する複数のセルから選ばれた２つ以上のセル、好ましくは全てのセルのそれぞれの電圧を検出する電圧検出手段である図示しない電圧検出器が設けられ、この電圧検出器の検出信号は、制御装置１１へ伝えられるようになっている。

【００３３】冷却系１２は、燃料電池スタック４の内部に設けられた図示しない冷却水流路と、冷却水を循環させる冷却水ポンプ７と、冷却水の熱を外部へ放熱するラジエータまたはラジエータとラジエータファンの組８と、燃料電池スタック４に流れる冷却水の方向を反転させる４方弁９と、冷却水温度を測定する温度計１０と、これらを接続する管路と、これらの内部に充填された冷却水とを備えている。

【００３４】そして、冷却系１２は、電圧検出手段によるセル電圧検出時に、燃料電池スタックのセル配列方向に燃料ガス及び酸化ガスの相対湿度分布を形成する湿度分布形成手段を構成している。

【００３５】また制御装置１１は、水素供給部１、空気供給部２及び温度計１０からの検出信号を受信する一方、水素供給部１、空気供給部２、冷却水ポンプ７、４方弁９を制御する制御信号を送出するようになっている。

【００３６】次に、冷却系１２による相対湿度分布形成の作用について説明する。水素供給部１及び空気供給部２から供給される水素含有ガス及び空気は、加湿器３を通過し、適当な湿度となった後、燃料電池スタック４の図中右側から供給される。この水素含有ガス及び空気は、加湿器３によりある絶対湿度に加湿された後、燃料電池スタック４の内部を右から左へ流れるに従って、発電により生成する水分により更に加湿されるので、絶対湿度が下がることはなく、寧ろ絶対湿度が上がると考えられる。

【００３７】冷却水方向を切り替える４方弁９は、制御装置１１からの制御に従って、通常運転時には実線の矢印方向に冷却水を流し、電圧検出器による電圧検出時には、破線の矢印方向に冷却水を流すように切り替える。これにより燃料電池スタック４を流れる冷却水は、通常運転時には図中右から左へ流れるので、この時の燃料電池スタック４内の温度分布は、図中右側が低く、左側が高くなる。

【００３８】一方、湿潤状態判定のための電圧測定時には、ガスの流れる方向とは反対に図中左から右へ冷却水が流れるので、この時の燃料電池スタック４内の温度分布は、通常運転時とは反対に図中右側が高く、左側が低くなる。従って、電圧測定時の燃料電池スタック４の相対湿度分布は、図中右側が低く、左側が高くなる。

【００３９】このような相対湿度分布を形成した状態で、燃料電池スタック４の複数セルのそれぞれの温度を測定すると、測定されたセルの位置に応じて、相対湿度の低いセルの電圧と、相対湿度の高いセルの電圧とを測定することになる。

【００４０】尚、第１実施形態の変形例として、通常運転時と湿潤状態判定のための電圧測定時とで冷却水方向を切り替えることなく、常に燃料電池スタックへのガス流入方向と冷却水入流方向とを反対方向として、燃料電池スタックに相対湿度分布が形成されるようにしてもよい。この変形例によれば、冷却水方向を切り替える４方

弁を省略して、図２に示す構成となるが、通常運転時の発電効率に多少の低下が生じるのはやむを得ない。

【００４１】次に、第１実施形態の動作を図３のフローチャートを参照して説明する。まずステップ（以下、ステップをＳと略す）１０１で燃料電池スタック運転中の電流及び電圧の検出を行う。次いでＳ１０２では、この検出された電流／電圧の組み合わせが予め記憶してある電流電圧特性より電圧低下しているかの判定を行い、電圧低下が認められなければ、Ｓ１０３以下に示した本実施形態の処理フローを実施することなく、再びＳ１０１へと戻る。

【００４２】電圧低下が認められた時は、電圧を適切に回復すべく、電圧低下の原因を精度よく判定する必要があるとし、本実施形態ではＳ１０３で水素や空気といったガスの燃料電池スタック４への入出力方向とは逆方向に冷却水の循環方向がなるように４方弁９を切り替える。この冷却水流入方向の切替により、燃料電池スタック４内には、上述のようにセル配列方向に相対湿度の分布が形成される。

【００４３】尚、図２に示した第１実施形態の変形例のように、燃料電池スタックへの冷却水の流入方向を常にガスの流入方向とは逆方向に設定され、冷却水流入方向を切り替えない構成となっている場合には、このＳ１０３は省略される。

【００４４】また、Ｓ１０２では電圧低下の有無を判定し、電圧低下が判定されたときに本ステップ以下を実行するとしているが、Ｓ１０１、Ｓ１０２を削除して、Ｓ１０３以下の処理を定期的に実行する構成としてもよい。

【００４５】次いで、セル配列方向に相対湿度の分布が形成された状態で、Ｓ１０４で燃料電池スタックを構成する各セルの電圧を電圧検出器で検出し、検出値を制御装置１１へ伝える。燃料電池スタック４は複数のセルから構成されるが、これら複数個のセル電圧はできるだけ同一時刻の値を検出できる構成とした方が望ましい。

【００４６】次いで、Ｓ１０５では、各セルの位置によるセル電圧の傾向を判定し、Ｓ１０６で、電圧低下の原因が膜の乾燥によるものであるか否かを判定する。

【００４７】図４は、各セル位置に対応するセル電圧分布の一例であるが、ガス入口側から出口側に向かって各セルの電圧を順番に並べて表現した図である。この図４のように、ガス入口側から出口側にかけてセル電圧が高くなるような傾向が得られた場合には、膜が十分に湿潤しておらず乾燥状態にあると判断を行う。

【００４８】これは、相対湿度の低い部分のセルの電圧が、相対湿度の高いセルの電圧より低いことを意味しており、即ち相対湿度の低い部分のセルの膜が十分に湿潤しておらず、電圧の低下の原因となっていると判断することが可能である。

【００４９】また図５に示すようなセル電圧分布が得られた場合、即ち相対湿度の分布とセル電圧の分布とに特に相関が見られない場合であるが、この場合には膜は十分に湿潤していると判断する。セル電圧と相対湿度に相関がない状態では、もしセル電圧が期待値よりも低いとしても、膜が乾燥しているのではなく、他の原因、例えば水素分圧の低下等によるものと判断してよい。

【００５０】尚、本実施形態において図６に示すような分布が得られた場合、即ちガス入口側の相対湿度の高い部分のセル電圧が、ガス出口側の相対湿度の低い部分のセル電圧に対して低いような分布が得られた場合であるが、この場合には、相対湿度の高い部分のセルに水分が貯まり、反応面積の低減により電圧が低下していると判断が可能である。

【００５１】以上のように、電圧低下の原因が膜の乾燥によるものと判断された場合、燃料電池スタック出力を制限し、スタック電圧がある設定値以下にならないように制御する（Ｓ１０７～１０９）、と同時に、燃料電池制御手段１１へ燃料電池スタックの出力要求を指令する上位の制御手段（図示せず）に、出力要求可能な上限値を通知する。

【００５２】これにより上位の制御手段は、燃料電池スタックの出し得る電力の最大値を認識しつつ、要求指令値の演算が可能になるので、予想外に出力されないという状態を防止することができる。

【００５３】尚、燃料電池スタックの出力制限は、Ｓ１０４～Ｓ１０６のように各セル電圧の位置に応じた傾向により膜の湿潤状態を推定した結果によって行ってもよい。

【００５４】また、燃料電池スタックの電圧や出力の制御手段であるが、電流制御機能付きのＤＣ／ＤＣコンバータを燃料電池スタックに接続して実施してもよく、詳細については省略する。

【００５５】また、電圧低下の原因が膜の乾燥以外であった場合には、その原因に対応した処理を行うブロックを実行する。例えば水素極側において窒素濃度が上がり、その結果水素分圧が低下しているような場合には、水素極をパージすることで水素分圧を上げるように制御を行う（Ｓ１１０）。

【００５６】一例としては、水素が循環系である場合には、燃料電池スタックからの排水素を戻すことなくシステム外部に排出し、また同時に水素流量を増大させることで水素極パージが可能であるが、本発明の本質でないので、詳細は省略する。

【００５７】〔第２の実施形態〕本実施形態の構成は第１の実施形態を示す図１と同一である。尚、本実施形態においては、ガスの流入方向と冷却水の流入方向を必ずしも逆にする必要はないので、４方弁９を省略することができる。

【００５８】図７に本実施形態のフローチャートを示す。本実施形態は燃料電池スタックの運転中の電流及び

電圧をある定まった時間以上、あるいは、ある定まったサンプリング数以上測定し、測定された電流及び電圧から内部抵抗値を演算し、その値から膜の乾燥状態を推定するものである。

【００５９】ここでいう内部抵抗値とは図１０（ａ）に示す電流ー電圧特性における中間部分の傾きに相当する。膜の水分量が減少するに従い、イオン伝導度が低下し、電気抵抗の増大のような形で観測される。

【００６０】即ち、十分湿潤していれば、図１０（ａ）における最も高い電圧を示す特性（以下、標準特性とする）となるが、乾燥気味になるにつれ、同じ電流値を燃料電池スタックから引き出した時の電圧が低下し、略直線部の傾きが急となり、結果、電流ー電圧特性は左下のような形へと推移することになる。

【００６１】またこの略直線部の傾きが標準特性のそれと同じであるが、ある電流値以上を取り出した時にのみ、急激に電圧の低下が認められた場合（図１０（ｂ））は、膜の湿潤状態は適当だが、ガスの状態（流量や圧力）が取り出した電流に対して適切ではないと判断を行う。

【００６２】また図１０（ａ）と図１０（ｂ）の状態が同時に発生する場合には、図１０（ｃ）に示すような電圧電流特性となり、略直線部の傾きが標準特性より急で、かつ、ある電流値以上を取り出した時、特性が直線から外れて電圧が低下した場合には、膜の湿潤が不足気味であり、かつ、ガスの状態が適切でないと判断することができる。

【００６３】以下に、燃料電池スタックの運転中に測定された電圧電流特性に基づいて内部抵抗を求める図７のフローチャートを説明する。

【００６４】まずＳ２０１で略同時刻の燃料電池スタックの電流及び電圧を検出する。このタイミングはできるだけ同時刻の方が望ましい。次いでＳ２０２では検出した電流の値によってデータのフィルタリングを行う。これは極小電流域での特性は内部抵抗の影響が出ていない為、そのような領域のデータをカットする為である。Ｓ２０３では、後述する内部抵抗演算で参照するために、測定した電流及び電圧の組データを記録手段に記録する。

【００６５】Ｓ２０４では、記録された電流及び電圧の組データが、内部抵抗算出に十分なものかどうかを判定する。十分と判定する条件として、電流値が広範囲に十分散らばっていること、組データ数がある設定値以上記録されていること、等がある。Ｓ２０５では実際に内部抵抗を演算する。具体的には複数個の電流及び電圧の組データを直線で近似し、その直線の傾きから求める。

【００６６】尚、複数個の電流／電圧の組データを直線で近似する方法については、各組データを示す点から近似直線までの距離の２乗の合計が最小となる近似直線を求める最小２乗法や、例えば特開平６－１７４８０８号公報に示された方法等がある。

【００６７】以上のような方法で求めた略直線部の傾きと、予め実験等で求めておいた標準特性とを比較し、傾きが急な場合には膜が乾燥していると判断し、出力の制限を行う等の処理を行い、スタックの劣化等悪影響を抑えることが可能となる。また略直線部の傾きが、標準特性のそれと略同一で、ある電流値以上の場合に電圧の低下が認められる時は、ガス条件に問題があるとし、パージ処理を行うことで水素極に蓄積された窒素を排出し、水素分圧を回復し、電圧の標準特性に戻すことが可能となる。

【００６８】尚、燃料電池の内部抵抗は、電極の抵抗、電解質のイオン導電度等、温度特性を有するので、例えば冷却水温を測定する温度計１０の測定結果に応じて、内部抵抗の標準値を変更することが好ましい。具体的には、実験的に求めたマップや、補正計算式を用いる。

【００６９】〔第３の実施形態〕図８は、本発明に係る燃料電池の第３の実施形態の構成を示す全体構成図である。本実施形態は、図１に示した第１の実施形態に対し、４方弁９を削除して燃料電池スタック４への冷却水流入方向をガス流入方向と常に同一とし、水素含有ガス及び空気の燃料電池スタック入出力部に水分流量検出手段を設けた例である。

【００７０】即ち燃料電池スタック４へ水素供給部１から流入する水分流量を検出する水分流量検出手段２１と、水素出口から流出する水分流量を検出する水分流量検出手段２２と、空気供給部２から流入する水分流量を検出する水分流量検出手段２３と、空気出口のから流出する水分流量を検出する水分流量検出手段２４とを設けている。これらの水分流量検出手段２１、２２、２３、２４としては、例えば鏡面冷却式等の露点検出手段と、質量流量検出手段で構成することが可能である。

【００７１】また制御装置１１では、燃料電池スタック４から取り出した電流値に応じて燃料電池スタック内部で生成された水分量を演算する手段が設けられている。

【００７２】燃料電池スタック４の入口の水素及び空気中の水分流量合計にスタック内部で生成された水分量を加えた値に対し、燃料電池スタック出口の水素及び空気中の水分流量合計が大きければ、膜から水分のガス中に出ていることを示し、即ち膜が乾燥傾向にあることを示している。

【００７３】逆に出口の水素及び空気中の水分量合計が小さければ、膜にガス中から水分が浸透していることになり、即ち膜が湿潤傾向にあることがわかる。よって、この水分の変化量を積分することにより燃料電池スタック内の平均的湿潤程度を推定することができるようになる。

【図面の簡単な説明】

【図１】本発明に係る燃料電池の第１の実施形態の構成を示す全体構成図である。

【図２】第１実施形態の変形例の構成を示す全体構成図である。

【図３】第１の実施形態の動作を説明するフローチャートである。

【図４】不十分な湿潤状態におけるセル位置に対するセル電圧分布例を示す図である。

【図５】適度な湿潤状態におけるセル位置に対するセル電圧分布例を示す図である。

【図６】過剰な湿潤状態におけるセル位置に対するセル電圧分布例を示す図である。

【図７】第２の実施形態の動作を説明するフローチャートである。

【図８】本発明に係る燃料電池の第３の実施形態の構成を示す全体構成図である。

【図９】（ａ）膜中の水分が減少した場合、（ｂ）水素分圧が低下した場合、（ｃ）膜中の水分が減少した状態で水素分圧が低下した場合のそれぞれ燃料電池の電流－電圧特性の代表例を示す図である。

【符号の説明】

１　水素供給部

２　空気供給部

３　加湿器

４　燃料電池スタック

５　燃料循環用ポンプ

６　逆止弁

７　冷却水ポンプ

８　ラジエータ

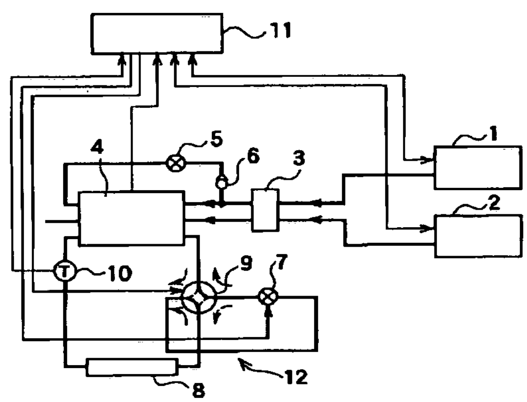
９　４方弁

１０　温度計

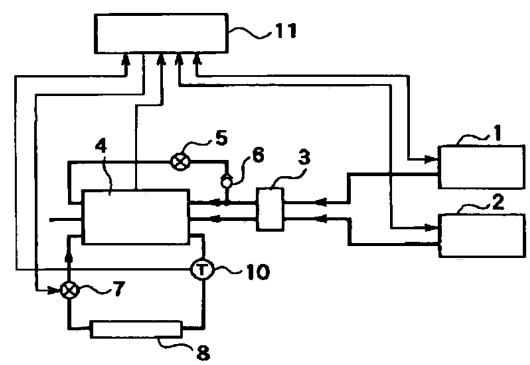
１１　制御装置

１２　冷却系

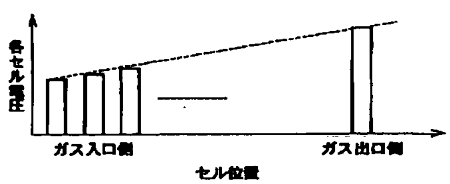
【図１】



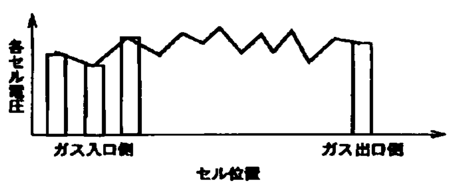
【図２】



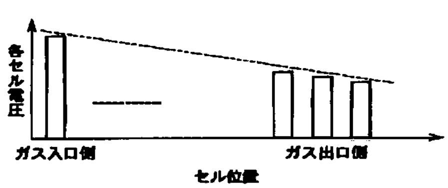
【図４】



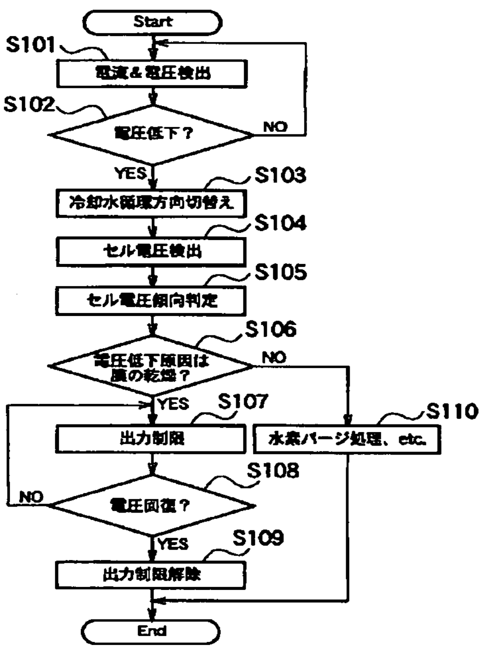
【図５】



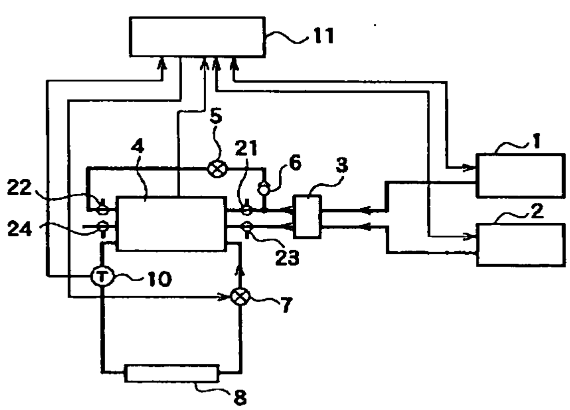
【図６】



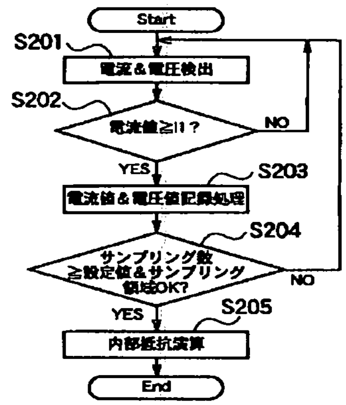
【図３】


Start
S101
電流＆電圧検出
S102
電圧低下？
NO
YES
S103
冷却水循環方向切替え
S104
セル電圧検出
S105
セル電圧傾向判定
S106
電圧低下原因は膜の乾燥？
NO
YES
S107
出力制限
S110
水素パージ処理、etc.
S108
NO
電圧回復？
YES
S109
出力制限解除
End

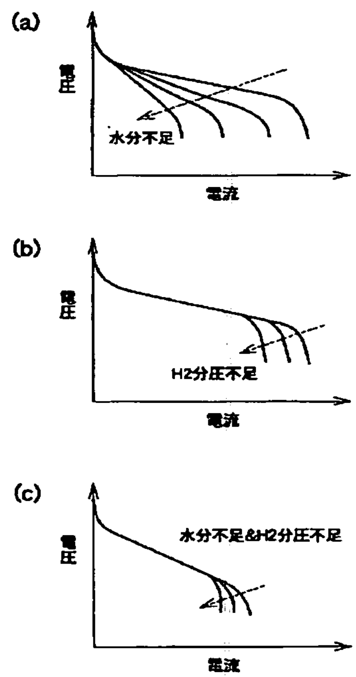
【図８】


11
5
4
21
6
3
1
22
24
2
23
10
7
8

【図７】


Start
S201
電流＆電圧検出
S202
電流値≧I1？
NO
YES
S203
電流値＆電圧値記録処理
S204
サンプリング数≧設定値＆サンプリング領域OK?
NO
YES
S205
内部抵抗演算
End

【図９】


(a)
電圧
水分不足
電流
(b)
電圧
H2分圧不足
電流
(c)
電圧
水分不足&H2分圧不足
電流